



Progress in preparing for climate change

2019 Report to Parliament

Committee on Climate Change
July 2019



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Book 2 of 2

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The Committee



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Michael Davies is Professor of Building Physics and Environment at the UCL Institute for Environmental Design and Engineering (IEDE). At UCL his research interests relate to the complex relationship between the built environment and human well-being. He is also Director of the Complex Built Environment Systems Group at UCL and a member of the Scientific Advisory Committee of 'Healthy Polis' – the International Consortium for Urban Environmental Health & Sustainability. Professor Davies was previously Director of the UCL Institute for Environmental Design and Engineering and a member of the London Climate Change Partnership Steering Group.



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Richard Dawson is Professor of Earth Systems Engineering and Head of Water in the School of Engineering at Newcastle University. Over the last two decades his research has focused on the analysis and management of climatic risks to civil engineering systems, including the development of systems modelling of risks to cities, catchments and infrastructure networks.

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Rosalyn Schofield is a solicitor. She is Director of Company Secretariat at Associated British Foods plc, where she has global responsibility for the environmental sustainability and impact of the business. Rosalyn is also a Trustee at Regent's University and Chair of the Audit and Risk Committee there as well as at the CCC. She has previously worked as Legal Director at JD Wetherspoon plc and was a commercial property lawyer in private practice.

Foreword

It has been a remarkable 12 months. Globally, the impacts of the changing climate have become increasingly visible. Public protests have led to widespread awareness of the risks of further climate change - and the remedies. And we have seen a renewed desire from governments around the world to step up their response.

Here in the UK, there are grounds for optimism. In May, the Committee's Net Zero report offered compelling analysis of the need to reduce greenhouse gas emissions in the UK effectively to zero by 2050 – and provided evidence that we could meet this new goal at a cost already agreed by Parliament. The net-zero target meets the UK's obligations under the Paris Agreement and responds to the urgent need for action highlighted by the IPCC in last year's landmark Special Report on 1.5°C of global warming.

We welcome strongly the UK Parliament's decision to make net zero law – and the corresponding decisions of the Welsh Assembly and the Scottish Parliament. These are positive steps which are of fundamental consequence for the future path of our economy, our society and the climate. Carbon neutrality has now become a mainstream goal.

But tougher targets do not themselves reduce emissions. New plans must be drawn up to deliver them. And even if net zero is achieved globally, our climate will continue to warm in the short-term, and sea level will continue to rise for centuries. We must plan for this reality. Climate change adaptation is a defining challenge for every government, yet there is only limited evidence of the present UK Government taking it sufficiently seriously.

It is time to act. Next year may see the UK host the most important global climate summit since Paris in 2015. Our credibility in the COP26 Presidency rests on real action at home.

The Adaptation and Mitigation Committees have reviewed the UK Government's approach to climate change adaptation and emissions reduction. Our reports are published in parallel, as required under the Climate Change Act. We find a substantial gap between current plans and future requirements and an even greater shortfall in action.

Planning for climate change adaptation is a statutory obligation but the National Adaptation Programme (NAP) is incomplete. Of the 56 risks and opportunities identified in the UK's Climate Change Risk Assessment, 21 have no formal actions in the NAP. Furthermore, we have been unable to give high scores for managing risk to any of the sectors we have assessed in this report. We are now seeing the substantial impacts of a global temperature rise of just 1°C. The Paris Agreement targets a threshold of well below 2°C, ideally 1.5°C, but current global plans give only a 50% chance of meeting 3°C.

In these circumstances, although the UK is committed to working for global action to parallel our own adoption of a net-zero statutory target, it is prudent to plan adaptation strategies for a scenario of 4°C, but there is little evidence of adaptation planning for even 2°C. Government cannot hide from these risks.

The Clean Growth Strategy, the UK's plan for emissions reduction, provides a solid foundation for the action needed to meet a net-zero GHG target but policy ambition and implementation now fall well short of what is required. Last June, we advised that 25 headline policy actions were needed for the year ahead. Twelve months later, only one has been delivered by Government in full. Ten of the actions have not shown even partial progress. Government continues to be off track for the fourth and fifth carbon budgets – on their own appraisal – and the policy gap has widened further this year as an increase in the projection of future emissions has outweighed the impact of new policies.

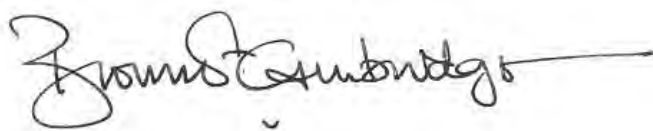
The central premise of the Climate Change Act is that the Government of the day holds the responsibility to act to protect future generations. This principle is at risk if the priority given to climate policy is not substantially increased over the next year and the next Government spending review.

The need for action has rarely been clearer. Our message to government is simple: Now, do it.



Lord Deben

Chairman, Committee on Climate Change



Baroness Brown of Cambridge

Chair, Adaptation Committee of the
Committee on Climate Change

Executive Summary



The Government has failed to increase adaptation policy ambition and implementation through its latest National Adaptation Programme - despite the increasing urgency of addressing the risks from climate change.

- **The climate of the UK is changing, and further change is inevitable regardless of how strongly the world reduces greenhouse gas emissions.**

Global average surface temperature over the 2006-2015 decade was 0.87°C (+/- 0.12°C) warmer than the pre-industrial period. The average annual temperature for England was around 1°C warmer. The ten warmest years on record in the UK have all occurred since 1990. The likelihood of experiencing a summer heatwave like that in 2018 in any particular year is now 10 - 20%, double the likelihood of a few decades ago. Sea levels are rising, and rainfall patterns are changing. The impacts of climate change are accelerating, and public concern about climate change is increasing as our level of understanding improves.¹

Up to at least 2050, temperatures in the UK are expected to increase regardless of how strongly emissions are reduced globally. The change in UK annual temperature by 2050 is expected to be between 0.5 and 2.7°C above the 1981 - 2000 baseline, depending on the pathway of global emissions. By 2050, the chance of experiencing a hot summer like 2018 is likely to be around 50% - so on average every other year. Sea level will continue to increase for centuries even on a low emissions pathway.

The world is not currently on track to meet the long-term temperature goal set out in the Paris Agreement, to keep global temperature rise well below 2°C, and to pursue efforts to limit the rise to 1.5°C, consistent with a low emissions pathway.

- **The National Adaptation Programme does not address all of the risks and opportunities set out in the UK Climate Change Risk Assessment.**

The Government's latest National Adaptation Programme (NAP2) is required under the Climate Change Act to address the risks and opportunities for England set out in the UK Government's own Climate Change Risk Assessment (CCRA).² The latest CCRA set out 56 risks and opportunities to address over the period 2018 - 2022, 38 of which are classed as 'more urgent', requiring additional action or research over and above what is currently taking place. Of the 56 risks and opportunities identified, 21 have no formal NAP actions, including 13 in the 'more urgent' categories. These omissions include the risks facing the UK from climate change overseas; opportunities from new species colonisations; changes in suitability of land for agriculture or forestry; and risks to health from changes in air quality driven by climate change. The NAP offers no explanation of why actions to address these risks are missing. Some key policy initiatives that should enable better adaptation, such as the Flood Re scheme, do not feature in the Programme. In addition, many of the actions in the NAP reflect work that is already underway, rather than new or strengthened initiatives to increase ambition and address the urgent risks and opportunities set out in the CCRA.³

¹ WMO (2018) *Statement on the State of the Global Climate*. References for all other facts and figures are provided in chapter 1.

² The NAP generally only covers England, though it also covers relevant UK reserved matters – a list is provided in chapter 1.

³ See analysis for each adaptation priority in chapters 2-5.

- **The priority given to adaptation, including through the institutional and support framework in England, has been eroded over the past ten years.**

The number of policy officials working directly on adaptation in Defra has fallen from several dozen in 2013 when the first NAP was published, to a handful for the second publication in 2018. Government funding for adaptation support services; the UK Climate Impacts Programme, the Environment Agency's Climate Ready programme and the Regional Climate Change Partnerships, has ceased. Reporting on adaptation was mandatory for the first round of the Adaptation Reporting Power (ARP) in 2011, but has since been made voluntary. A CCC survey of perceptions of the UK's role as an adaptation leader suggests that whilst the UK is still generally considered a leader internationally in climate change legislation and research, adaptation action is lagging behind what is needed, and the country is at risk of becoming complacent.

- **On the basis of the evidence available, England is not prepared for even a 2°C rise in global temperature, let alone more extreme levels of warming. Many national plans and policies still lack a basic acknowledgement of climate change, while others make a passing mention but have no associated actions to reduce risk.**

The combined current emissions reduction commitments from all countries around the world are consistent with pathways with around a 50% chance of warming exceeding 3°C by 2100. Given that even those commitments might not be met, it is imperative that the Government considers the risks from a 4°C world before 2100 in adaptation planning.

Of the 33 'adaptation priorities' assessed in this report (see figure ES.1), plans for 12 of them appear to include no assessment of the long-term risks from climate change and the threat of 'locking in' irreversible change from decisions being taken today.⁴ The Committee has expressed particular concern about the lack of long-term planning related to coastal change, land use and housing policy, and has published reports on these issues over the last year.

Plans for the other 21 adaptation priorities in this report do consider the long-term risks from climate change, but there is little evidence that a 2°C rise in global temperature is being planned for, let alone any assessment of adapting to a 3 or 4°C rise. The exceptions to this are planning for future public water supply, flood risk planning for new defences and infrastructure, and planning for roads and rail by Highways England and Network Rail. The Environment Agency is also currently undertaking an exercise to consider how its operations could be affected by a 4°C rise in global temperature.

Planning for a minimum of 2°C, with consideration of more extreme scenarios should be a Government requirement for all departmental and public sector plans and policies that are likely to be affected by climate change.

- **Vulnerability and exposure to climate change continue to increase across a range of sectors that are classed in the CCRA as needing urgent action. For some others, gaps in data mean we are unable to assess the effects of actions on risk.**

Vulnerability and exposure to climate change are increasing across a range of priority areas; including terrestrial and freshwater habitats; development in flood risk areas; risks to health from heat and cold; and risks to health from changes in air quality. Urban greenspace, which has a host of benefits for reducing flood and heat risks, continues to decline, from 63% of urban area

⁴ These are: commercial fisheries and aquaculture; farmland habitats and species; agricultural productivity; development in areas of surface water flood risk; surface water flood alleviation; health impacts from heat and cold; human pathogens; infrastructure interdependencies; resilience of telecoms, digital and ICT; extreme weather impacts on businesses; supply chain interruptions; and opportunities for businesses from climate change.

in 2001 to 55% in 2018. The proportion of impermeable surfacing in towns and cities, which increases flood risk, has risen by 22% since 2001. The number of people with chronic respiratory conditions that make them more vulnerable to poor air quality continues to increase. The abundance of woodland and farmland birds, butterflies and pollinators is declining, increasing the vulnerability of these groups of species to climate change. In addition, the condition of terrestrial and freshwater habitats is not improving quickly enough to meet Government targets.

Better, more targeted data are needed to measure changes in vulnerability and the impacts of climate change in the natural environment. The Lawton principles, established in 2010, for improving the resilience of the natural environment by making habitats 'bigger, better, more numerous and more joined up' have provided a sound basis to date for evaluating vulnerability. However, research and monitoring has generated new knowledge and understanding about which habitats and species are likely to be the most sensitive to climate change, and how climate change will impact the provision of different goods and services. These advances have yet to be translated into science-based monitoring of risk.

There are still substantial gaps in our understanding, including: how businesses are impacted by extreme weather and the actions they are taking to prepare for climate change; trends in vulnerability and exposure to surface water flooding and coastal erosion; the resilience of infrastructure services including ports and airports, telecoms, digital and ICT; and infrastructure interdependencies.

In this report we highlight additional indicators that need to be monitored to provide a comprehensive understanding of climate change risks, and the effectiveness of adaptation, in the UK.⁵

- **Defra's 25 Year Environment Plan is an opportunity to integrate wider environmental and climate considerations. However, there is a worrying lack of recognition that meeting almost all of the Plan's long-term goals will require climate change risks to be addressed.**

Adaptation is treated in the 25 Year Environment Plan as a separate goal, yet it is a necessary pre-requisite to meeting most of the Plan's other goals. This disconnect is also evident in the draft Environment Bill, which includes 'environmental matters' in the remit of the proposed Office for Environmental Protection, but excludes climate change. The same issue feeds through into the list of proposed environmental metrics to track progress of the 25-year Plan; the resilience category is missing most of the relevant resilience metrics, which appear elsewhere, and some key risks are not covered.

The Government's Industrial Strategy makes no mention of climate change as a risk to meeting its goals, nor as an opportunity for UK skills, services, and technologies to support adaptation efforts. Some action by businesses is underway to address the risks and take advantage of opportunities from climate change, but significant gaps remain in considering the risks to trade, international flows of finance and the need for new skills, for example in the housing and infrastructure sectors.

There are pockets of excellence in adaptation planning and action that need to be supported, extended and mirrored by others over the next ten years.

Many actions, whether included in the National Adaptation Programme or not, are helping to reduce vulnerability and exposure to climate change, but progress is piecemeal.

⁵ See Appendix B.

The water sector continues to make detailed plans for dealing with a range of future water availability scenarios, as it has done for over 20 years. Metering of properties continues to increase, but more can and needs to be done to reduce consumption and leakage further and faster, to manage the risks from reduced water availability in the future.

The Environment Agency is in the process of developing an ambitious flood and coastal erosion risk management strategy, which has the potential to form an overarching national strategy for flooding, with clear objectives and targets.

Significant progress has been made towards better assessment and disclosure of the physical risks from climate change in the finance sector, driven by FTSE100 companies, but with a focus to date only on 2°C global temperature rise and not the 4°C relevant for adaptation risks. Green finance concepts and products, for example green bonds, will have a large role to play in the implementation of the Government's 25 Year Environment Plan and are a significant opportunity to advance adaptation financing.

There is evidence of long-term planning and improving resilience in the road, energy and rail sectors, though vulnerability indicators remain challenging to measure. Many of the resilience plans for the infrastructure sector take account of a range of future climate scenarios, though not all do.

In the marine and fisheries sectors, there is evidence of recovery of fish stocks from historically low levels, and a high proportion of protected coastal habitats are in good condition.

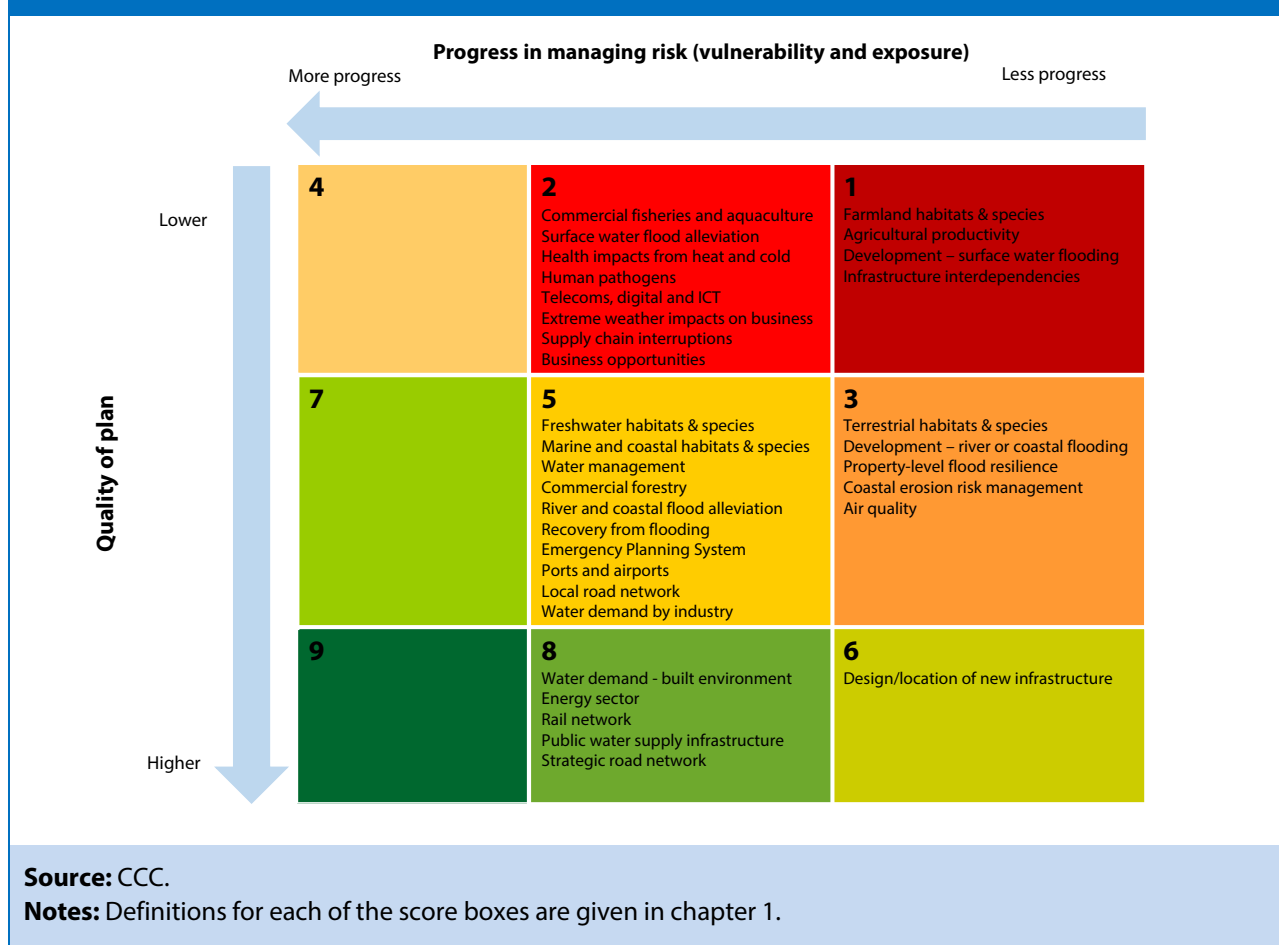
Our assessment of progress has scored different adaptation priorities on how well plans recognise and set out actions to address climate change, and whether there is evidence of the risks from climate change being managed.

For this report, the Committee has introduced a new scoring system to give a simpler assessment of progress, with higher scores denoting better progress. The results of our assessment are shown in figure ES.1 below.

Some sectors, including strategic roads, public water supply, and rail have good plans in place that consider the long-term risks and opportunities from climate change, and there is at least some evidence that risk is being managed. At the other end of the scale, much still needs to be done to improve plans, actions and risk reduction across many aspects of the natural environment and agriculture, health, business, and some aspects of infrastructure and flood risk management.

The Committee will update these progress scores in our next report in 2021. In many cases, improvements in scores should be possible by improving the clarity of plans, showing analysis that considers 2°C and 4°C, and demonstrating how the gaps in action identified in the CCRA are being addressed. These improvements in planning for climate change are not necessarily costly or difficult, but until they are addressed we cannot be confident that England is preparing for the risks of a changing climate.

Figure ES.1. The Adaptation Committee's scoring of adaptation priorities



Leaving adaptation responses to local communities and individual organisations without a strategic plan is not a strategy to manage the risks from climate change.

Climate change impacts and adaptation are associated with market failures, and institutional or behavioural barriers that require Government intervention.⁶ These barriers are caused partly by adaptation requiring numerous interactions through time and between communities, regions, and economic sectors. There is also uncertainty in the precise magnitude and future timing of climate change impacts. For individual businesses, organisations or the public, it is extremely challenging to build awareness and take adaptation actions at a scale that is effective and efficient, and that accounts for social costs and benefits, without centralised support and direction where needed.

Climate change is also not a discrete policy issue that falls neatly under a single department's remit. It will affect the Government's ability to meet a very wide range of goals and objectives.⁷ This includes the majority of the goals set out in the Government's 25 Year Environment Plan and some in the Industrial Strategy. Ignoring the climate change implications of decisions being taken now will lead to increased risks or irreversible damage in the future, and make the delivery of related goals more costly; known as 'lock in'. In contrast, adaptation actions taken today to manage these risks will have benefits long into the future.

⁶ Frontier Economics et al. (2013) *Economics of Climate Resilience*; Mullan, M. and Cimato, F. (2010) *Adapting to climate change: analysing the role of Government*.

⁷ Watkiss, P., Cimato, F., Hunt, A. and Moxey, A. for the CCC (2019). *The impacts of climate change on meeting government outcomes in England*.

These factors mean that adaptation action will not be successful without a strong, integrated, strategic national plan. Given the piecemeal nature of the NAP, the gaps within it, the decline in resources and local support, and the lack of progress in managing risks, the Committee's view is that the Government's approach of mainstreaming adaptation has, so far, not succeeded in putting in place a coherent and coordinated plan, nor the resources to enable the required actions to be carried out.

The UK Government must raise the profile, and strengthen the governance, of preparations for the impacts of climate change. It should ramp up resources and action on all of the urgent risks set out in the UK Climate Change Risk Assessment, continue to take appropriate action for those classed as less urgent (but still important), and monitor the effects on climate risk over the next five year period.

Work is underway to prepare the next UK Climate Change Risk Assessment (CCRA), due in 2022. The CCRA3 Evidence report will present the latest evidence of how climate risks and opportunities are changing for the UK and what the urgent priorities should be for the Government in the 2020s. If the change in climate for the UK follows global trends, we will expect CCRA3 to show a further increase in climate risk, underlining the urgency of a step change in the level of effort – resource and action – on adaptation over the next few years.

In addition to our assessment of progress, we make some specific recommendations below for how this important programme of work can be improved.

Recommendations

RECOMMENDATION 1: Little progress is being made in planning for and addressing climate change risk in key areas. These areas include, but are not limited to, farmland habitats and species; agricultural productivity; commercial fisheries and aquaculture; development in areas of surface water flooding; infrastructure interdependencies; health impacts from heat and cold; and risks and opportunities to businesses.⁸ Effective plans, actions and evidence of risk reduction for adaptation are needed over the rest of this NAP period and beyond. (Departmental owners – Defra, DHSC, MHCLG, BEIS, Cabinet Office. Timescale – by 2021).

RECOMMENDATION 2: Additional priority indicators are required to guide and allow evaluation of adaptation actions and impacts, and to ensure effective use of taxpayers' money. A list of priority indicators is included in appendix B. Defra, in its response to this report, should set out where suitable data are already being collected, and a process for working with the CCC and other organisations to design and populate the indicators. (Departmental owner – Defra. Timescale – by end 2019).

RECOMMENDATION 3: Adaptation plans are needed to address the scale of climate risk that the UK faces from climate change impacts overseas. Cross-government working is required to develop and implement these plans. (Departmental owners – Defra, FCO, DIT, DfID, Home Office. Timescale – by 2021).

RECOMMENDATION 4: Adaptation must be integrated systematically into the 25-year Environment Plan goals and the Environmental Land Management Scheme (ELMS) outcomes. Actions that reduce vulnerability and exposure to climate change related to any of the environmental outcomes should be rewarded under ELMS. The Adaptation Committee will evaluate progress in adaptation related to the goals set out in the 25-year Plan, and report on

⁸ This list is those adaptation priorities that have scored 1 or 2 in our assessment framework and are associated with 'more urgent' CCRA risks or opportunities.

this to the Office for Environmental Protection when it has been set up; including but not limited to terrestrial and freshwater habitats and species; fisheries; and soil health (Departmental owner – Defra. Timescale – by 2022).

RECOMMENDATION 5: Additional action and coordination are required to ensure water continues to be available to people, industry, agriculture and the environment. Targets should be set and options developed to achieve greater progress in reducing water use by households and businesses and reducing the amount of water lost to leakage. Greater assurance about the level of resilience being planned for and how trade-offs with other outcomes, like keeping customer bills low, needs to be considered. (Departmental owner – Defra (with Ofwat and the EA). Timescale – by 2021).

RECOMMENDATION 6: Near-term milestones are required for transitioning to the withdrawal of Flood Re in 2039, including joint strategies and targets to accelerate the implementation of property-level flood resilience measures in England. (Departmental owner - Defra (with Flood Re). Timescale – by 2023).

RECOMMENDATION 7: The Environment Agency's draft Flood and Coastal Erosion Risk Management (FCERM) strategy is a significant improvement over previous versions in that it sets long-term objectives to improve resilience to flooding and coastal change and is aligned with the adaptation gaps identified in CCRA2. Defra should approve the strategy and align its upcoming FCERM Policy Statement with the strategy. (Departmental owner – Defra. Timescale – by 2020).

RECOMMENDATION 8: The National Planning Policy Framework (NPPF) and planning practice guidance (PPG) should be updated to ensure that Sustainable Drainage Systems (SuDS) installations maximise their impact in terms of flood risk reduction and their co-benefits. This could be done by aligning the NPPF and PPG with the aims of Schedule 3 of the Flood and Water Management Act (2010). (Departmental owner – MHCLG. Timescale – by 2021).

RECOMMENDATION 9: The Government still needs to publish an integrated plan to reduce overheating risk in existing and new homes, alongside decarbonising domestic heating, and planning for at least a 2°C increase in global temperature, with consideration of 4°C. (Departmental owner – MHCLG. Timescale – as soon as possible).

RECOMMENDATION 10: A plan is needed to address the risks of overheating in care homes and care facilities, including consideration of home-based care. (Departmental owner - DHSC (with CQC). Timescale – by 2021).

RECOMMENDATION 11: It remains unclear what action is being taken to reduce the climate risks related to infrastructure interdependencies. Cabinet Office should ensure that data sharing arrangements are in place between infrastructure providers and Local Resilience Forums, and provide evidence to the CCC that this is happening. The Government should also ensure that the Adaptation Reporting Power is used effectively to present updated risks and adaptation actions that allows for an assessment of preparedness of all infrastructure sectors and their interdependencies. (Departmental owners - Defra, Cabinet Office. Timescale – by end 2019).

RECOMMENDATION 12: Further research is needed to understand the size of climate-related business opportunities. BEIS should also set clear deadlines for ensuring listed companies and large asset owners report on climate-related risks and opportunities, as recommended by the Green Finance Taskforce and Environmental Audit Committee. This should include committing to new legislation if reviews find that the quality of reporting does not improve. Both transition and physical risks need to be addressed, supported by appropriate climate scenarios and data. (Departmental owner - BEIS (with UKRI). Timescale – by 2021).

Introduction



1.1 Purpose of this report

This is the Adaptation Committee's first assessment of the UK Government's Second National Adaptation Programme.

The Climate Change Act 2008 (the Act) requires the Government to present to Parliament an assessment of the climate change risks and opportunities for the United Kingdom every five years. The second Climate Change Risk Assessment (CCRA2) was presented to Parliament in January 2017.⁹ Following the publication of each CCRA, the Government must lay out its objectives, policies and proposals to address the climate change risks and opportunities it identifies. The second National Adaptation Programme (NAP2), setting out these objectives, policies and proposals, was published in July 2018,¹⁰ superseding the first NAP from July 2013.¹¹ The programme covers devolved policies in England together with reserved policies for the UK as a whole.¹²

The Committee on Climate Change is required by the Climate Change Act to assess the NAP and present a progress report to Parliament every other year.

This assessment is presented alongside the latest report of the Mitigation Committee on progress in reducing UK greenhouse gas emissions. Two CCC assessments of the first NAP (NAP1) were completed, in June 2015 and June 2017.¹³ The Government is required under the Act to respond to each of the Adaptation Committee's statutory progress reports by 15 October in the same year. The Government's response to the CCC's final progress report on the first NAP (NAP1) was published in October 2017.¹⁴

Section 1.5 of this report provides an overview of the second NAP and a summary of the Committee's high level reflections on the second programme.

We will update our assessment of NAP2 in 2021, based on action that takes place between now and then.

The Climate Change Act also includes a power to require relevant organisations, such as public bodies and infrastructure providers, to report on the progress being made in adapting to climate change – the Adaptation Reporting Power (ARP). Two rounds of reporting were completed under the first NAP. The second NAP details how the Government will manage the third cycle of adaptation reporting.

1.2 The latest climate science and observations

Observations

2018 was the joint warmest summer and seventh warmest year in the UK since 1910.¹⁵

⁹ The first UK Climate Change Risk Assessment (CCRA) was published in January 2012.

¹⁰ HM Government (2018) *The National Adaptation Programme and the third strategy for climate adaptation reporting*.

¹¹ HM Government (2013) *National Adaptation Programme*.

¹² Reserved matters in the UK include: benefits and social security, broadcasting, constitution, defence, employment, equal opportunities, foreign policy, immigration, trade and industry.

¹³ CCC (2015) *Progress in preparing for climate change: 2015 report to Parliament*; CCC (2017) *2017 Report to Parliament – Progress in preparing for climate change*.

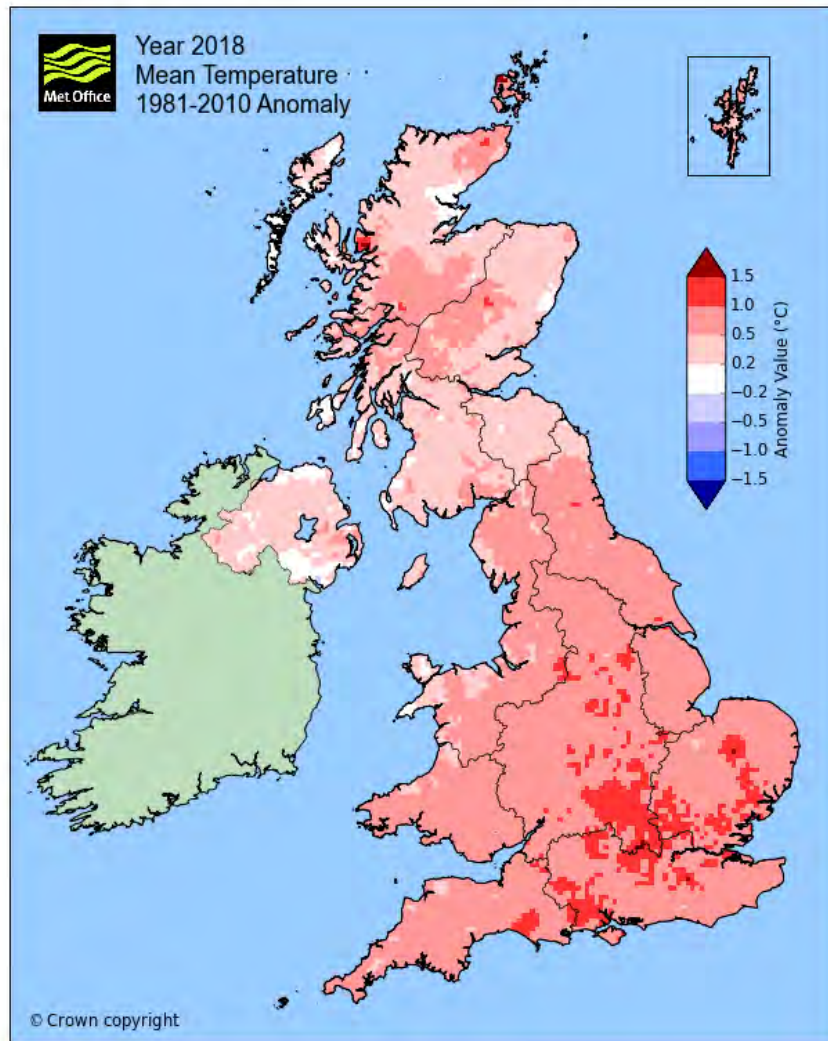
¹⁴ HM Government (2017) *Government response to the Committee on Climate Change*.

¹⁵ <https://www.metoffice.gov.uk/climate/uk/summaries/2018/annual>

Globally, average surface temperature over the 2006-2015 decade was 0.87°C (+/- 0.12°C) warmer than the 1850-1900 (pre-industrial) period.¹⁶

For the UK, annual average temperature for 2018 was 9.5 °C, which is 0.6 °C above the 1981–2010 long term average (figure 1.1).

Figure 1.1. UK average temperature in 2018



Source: <https://www.metoffice.gov.uk/climate/uk/summaries/2018/annual>.

Notes: Shows 2018 annual average temperature anomalies (°C) relative to the average of the 1981 – 2010 period.

Nine of the ten warmest years for the UK have occurred since 2002 and all the top ten warmest years have occurred since 1990.¹⁷ In the recent past (1981-2000) the chance of seeing a summer

¹⁶IPCC (2018) *Chapter 1 - Framing and Context* and IPCC (2013) *Summary for policymakers, Working Group 1 - 5th Assessment Report*.

¹⁷ Kendon et al. (2018) *State of the UK Climate 2017*.

as hot as 2018 was low (<10%). The chance has already increased as a result of climate change and is now between approximately 10–20%, and will increase further.¹⁸

For England, the longest running instrumental record of temperature in the world, the Central England Temperature dataset, shows that the most recent decade (2008–2017) was around 1 °C warmer than the pre-industrial period (1850–1900).¹⁹

There has been a slight increase in annual average rainfall over the UK in the last few decades, but with a very dry summer in 2018.

An increase in annual average rainfall is particularly marked over Scotland for which the most recent decade (2008 – 2017) has been on average 4% wetter than 1981 – 2010.²⁰ Trends in heavy rainfall over the UK vary according to the metric used; some of the Met Office’s metrics for heavy rain show an increase since 1960, whilst others do not.

At the seasonal scale, UK summers for the most recent decade (2008 – 2017) have been on average 17% wetter than 1981 – 2010 and 20% wetter than 1961 – 1990, with only summer 2013 drier than average.²¹ The summer of 2018, however, was the driest since 2003.²² These trends may be showing increasing variability in summer rainfall compared to the long-term average, but a longer time series is needed to confirm this.

Wildfire trends across the UK show a short-term decline, though these statistics do not yet include the serious moorland fires seen in 2018 and 2019.

The number of wildfire incidents and the area affected have been notably smaller in the last five years (2012 – 2013 to 2016 – 2017) than in the three years prior to this (2009 – 2010 to 2011 – 2012) (see chapter 2).²³ The Forestry Commission has not yet updated its statistics to include 2018 and 2019. Several serious moorland fires have occurred during this time including on Saddleworth Moor and Winter Hill in summer 2018. Spring fires have also been recorded in early 2019 (for example on Marsden Moor, started by a barbeque but then taking hold due to unusually dry conditions).²⁴

Sea level has increased around the UK.

Observations show that the sea level around the UK has already risen by about 16 cm since 1900²⁵ and the mean rate of sea level rise around the UK was approximately 1.4 mm/yr in the 20th century.²⁶

¹⁸ Met Office (2018) *UKCP18 Science Overview report*, November 2018. See also Met Office for the CCC (2019) *Time lags and committed change in the climate system*.

¹⁹ Kendon et al. (2018) *State of the UK Climate 2017*. The latest State of the Climate Report for 2018 is due out in summer 2019.

²⁰ Met Office (2018) *UKCP18 Science Overview report*, November 2018.

²¹ Kendon et al. (2018) *State of the UK Climate 2017*. The latest State of the Climate Report for 2018 is due out in summer 2019.

²² <https://www.metoffice.gov.uk/climate/uk/summaries/2018/annual>

²³ Forestry Commission England (2018) *Wildfire statistics for England, 2009–10 to 2016–17*.

²⁴ Wildfire risk is driven by a combination of factors; human activity or lightning are usually the factors leading to fires starting, but certain weather conditions (warm, dry and windy) can lead to fires spreading quickly, as was the case in 2018 and 2019. The habitats affected in moorland fires are often upland peat areas. Marsden Moor is designated as a Site of Special Scientific Interest, a Special Protection Area and Special Area of Conservation due to the ground nesting bird population and blanket bog habitat (National Trust).

²⁵ Ibid. This sea level rise estimate takes into account changes in land movement, and the figure recorded is therefore the change in sea level that is actually experienced.

²⁶ Met Office (2018) *UKCP18 Science Overview report*, November 2018.

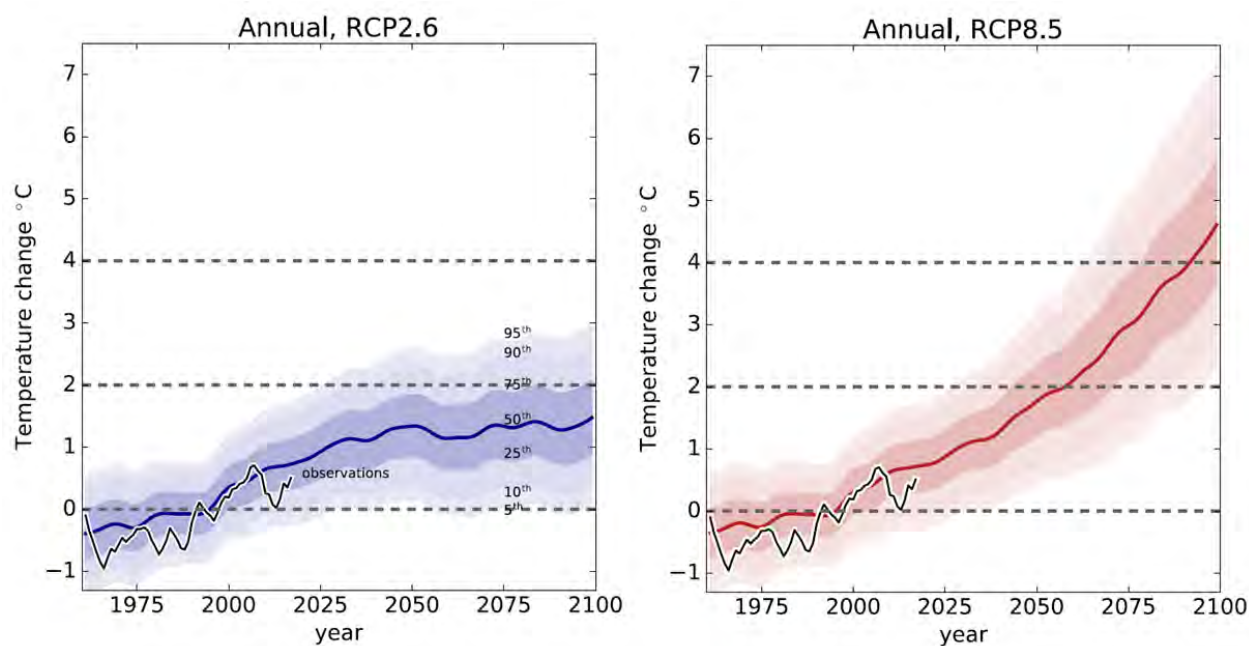
Future projections

The latest UK climate projections (UKCP18) suggest that the UK climate will continue to warm over the rest of this century, and on average, rainfall is expected to increase in winter and decrease in summer, though individual years may not conform to this pattern.

UKCP18 gives projections of UK annual-average temperature increasing to between 0.5 and 5.7°C above a 1981 - 2000 baseline by the end of the century, depending on the future emissions trajectory and taking into account model uncertainty (figure 1.2).²⁷

Figure 1.2 also shows that at least to 2050, temperatures in the UK are expected to almost certainly increase regardless of how strongly emissions are reduced globally. The change by 2050 shown in Figure 1.2 is between 0.5 and 2.7°C above the 1981 - 2000 baseline, depending on the pathway of global emissions.²⁸ By 2050, the chance of experiencing a hot summer like 2018 is expected to be around 50% regardless of emissions trajectory (i.e. it will take place on average every other year).²⁹

Figure 1.2. UK average temperature projections under low and high emissions scenarios to 2100



Source: Lowe, JA. et al. (2018) *UKCP18 Science Overview Report*. Met Office Hadley Centre.

Notes: UKCP18 UK area mean temperature is shown for the lowest emission scenario (RCP2.6, blue) and highest emission scenario (RCP8.5, red). The shading boundaries show the 5th, 10th, 25th, 50th (median, central solid line), 75th, 90th, and 95th percentiles. NCIC observations (<https://www.metoffice.gov.uk/climate>) are shown as a black line for the historical part of the curves. Values are expressed relative to the 1981-2000 baseline used in UKCP18 projections. RCP2.6 is a scenario for global emissions in which global emissions of all greenhouse gases fall very rapidly from today, with net removals of CO₂ from the atmosphere by the end of the century. It would be expected to lead to a greater than two-in-three chance of warming staying below 2°C above pre-industrial levels.

²⁷ <https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf>. The range given here is the 10th percentile for the RCP 2.6 pathway to the 90th percentile of the RCP 8.5 scenario.

²⁸ Range given is from the 10th percentile of the RCP2.6 scenario to the 90th percentile of the RCP 8.5 scenario.

²⁹ Ibid.

Winter precipitation is expected to increase significantly, and summer precipitation decrease significantly, on average. UKCP18 gives a range of projections of UK average rainfall change of up to 35% more rainfall in winter and 47% less rainfall in summer by 2070.³⁰ Some of the projections though show a chance of drier winters and wetter summers, so there remains more variability in projections of rainfall compared to that for temperature.

Sea levels around the UK have increased and will increase significantly more according to the latest climate change projections.

UKCP18 indicates that, by 2100, sea level on the coast near London, for example, is expected to rise by between 29 – 70 cm under a low emissions scenario (approximately 1.6 degrees of mean global warming above pre-industrial levels) and by between 53 – 115 cm under a high emissions scenario (approximately 4 degrees of warming above pre-industrial levels).³¹ Over longer timescales, global sea level is expected to rise for centuries from now regardless of the world's climate change mitigation efforts, due to the long response time of sea level to past emissions of greenhouse gases. The accompanying briefing note to this report from the Met Office sets out the reasons for the long time lag in sea level response to emissions. Recent estimates project at least 1 metre of sea level rise by 2300³² and potentially higher depending on our eventual emissions pathway and on the uncertainties in the way that the major ice sheets in Greenland and Antarctica will respond to climate change.³³

Adaptation is needed now and in the future, no matter how successful the world is at reducing greenhouse gases.

Mitigation actions in the UK and globally will become more important after 2050 for determining the climate hazards experienced by the UK. Mitigation actions taken today will have an effect on some hazards within decades³⁴, whilst other hazards (such as sea-level rise) will continue to increase for centuries as a result of present and past emissions due to a time lag in the climate system. As set out above, it is highly likely that some amount of future warming will be experienced in the UK even under the most ambitious pathways of global greenhouse gas mitigation. Adaptation actions must therefore be taken to prepare for climate change impacts that are likely in all plausible futures, alongside planning for the chance of more severe impacts that will depend on the success or otherwise of global mitigation activities. At levels of warming above 4°C, there are very likely to be limits to adaptation in the UK for some impacts, meaning that no amount of adaptation can reduce the risk to below today's levels.³⁵

1.3 Ten years of adaptation policy in the UK

The Climate Change Act and the Committee on Climate Change are just over ten years old.

Passed in November 2008, the Climate Change Act formalised the way the UK tackles climate change and created the independent Committee on Climate Change.

³⁰ Ranges of UK average precipitation changes are -1% to +35% for winter, and -47% to +2% for summer, where positive values indicate more precipitation and negative values indicate reduced precipitation.

³¹ Ibid. Projections are for sea level rise by 2100 relative to 1981-2000. RCP2.6 and RCP8.5 are the low and high emission scenarios used. The range is very likely (5th-95th percentile).

³² Nauels et al. (2017) Synthesizing long-term sea level rise projections – the MAGICC sea level model v2. *Geoscientific Model Development*, 10, 2495–2524.

³³ DeConto and Pollard (2016) Contribution of Antarctica to past and future sea-level rise. *Nature*, 531, 591–597. See also CCC (2018) *Managing the coast in a changing climate*.

³⁴ Ciavarella, A., Stott, P. & Lowe, J. (2017) Early benefits of mitigation in risk of regional climate extremes. *Nature Climate Change*, 7 (5), p.326.

³⁵ CCC (2016) *UK Climate Change Risk Assessment 2017: Evidence Report*.

A report, in 2018, by the Grantham Research Institute identified the Climate Change Act as being instrumental in advancing climate action over the past decade. It highlighted the key achievements of the Act as:

- Improving the political debate on climate change;
- Preserving political consensus on the need for climate action and the UK's long-term ambition;
- Increasing the UK's international standing, helping the UK to play a leadership role in negotiating the Paris Agreement and inspiring other countries to take action; and
- Transforming the power sector, helping the UK to meet its first two carbon budgets and decouple domestic greenhouse gas emissions from GDP.³⁶

Over the past ten years, there has been an erosion of the governance and coordination of adaptation policy within the UK Government.

Following the publication of the 2009 UK Climate Projections, the Prime Minister asked sixteen departments to produce Departmental Adaptation Plans, which were published in 2010.³⁷ These Plans contained a detailed assessment of the adaptation plans and policies of each department; something that has not been replicated in the subsequent two iterations of the National Adaptation Programme in 2013 and 2018. Government funding for adaptation support services - for the UK Climate Impacts Programme between 1997 and 2009, Climate Ready between 2010 and 2017 and the nine Regional Climate Change Partnerships has also ceased. Dozens of officials worked in the climate team in Defra, and with other departments to create the first NAP in 2013. Only a handful of officials existed in the same team in 2018. The risks and opportunities set out in the CCRA affect nearly every department across Government, and a suitably resourced coordinating team is essential to bring the work underway together and drive further ambition in areas where it is needed, with appropriate Ministerial support.

The UK may still be considered a leader in climate change adaptation internationally, but there is a sense that progress has slowed and that there is a risk of complacency.

A recent survey conducted by the CCC asked climate change practitioners in the UK and overseas about their perceptions of the UK as an international leader on adaptation. Sixty people responded, including academics, representatives of national, regional and local governments, consultants and employees of NGOs in the UK and from 21 other countries. Almost three quarters of respondents have been working in climate change for at least six years and half for more than ten years, i.e. before the passing of the Climate Change Act. Just over half of the survey respondents considered the UK to be an international leader in climate change adaptation. Their comments applied especially to the governance framework and the skills base in the UK in research, for example:

- "The framework created by the Climate Change Act is I think still in the top tier internationally and the UK has been a consistent champion on climate change internationally."
- "The Climate Change Act has thrown a significant light on vulnerabilities and has got the attention of many organisations who are responding to the issues."

³⁶ Fankhauser et. al (2018) *10 years of the UK Climate Change Act*, Grantham Research Institute on Climate Change and the Environment.

³⁷ <https://climate-adapt.eea.europa.eu/metadata/publications/uk-departmental-adaptation-plans>

- “Strong work on risk assessment including transferable methodologies. Struggling with similar issues as other countries, including monitoring and evaluation of action.”
- “Our research excellence is certainly something to be cherished and of great value internationally.”

Proportionately, more overseas than UK-based respondents considered the UK to be a leader. Of all international respondents, around 72% see the UK as a leader, whilst 22% do not. In the UK, 50% of respondents consider the UK to be a leader, 35% do not.³⁸

The comments from those respondents who felt the UK is not, or is no longer, a leader on adaptation pointed to the longstanding difficulties in framing adaptation against mitigation, and lack of action 'on the ground' to reduce risk, for example:

- “Adaptation is the poor relation to mitigation. We need to reframe the narrative.”
- “I think we have strong policies but are failing to scale up solutions fast enough. There are poor regulatory incentives and as a country we are fixated on cost rather than value.”
- “Clear leadership on adaptation processes (CCRAs, NAPs, CCC etc.); the case is less obvious on actual adaptation action (e.g. flood protection, infrastructure resilience, disaster preparedness), though the UK is not necessarily behind [other countries].”
- “But we are in danger of resting on our laurels because we have world leading legislation and scientists. The challenge is getting bigger, time is getting shorter and we need to drastically up our game.”

Scotland, Wales and Northern Ireland have their own adaptation programmes; updated programmes are currently being developed in Scotland and Wales.

These programmes should contain policies and actions to address the climate risks set out in CCRA2 for all policy matters that are not reserved to the UK level. The Adaptation Committee completed the second independent assessment of the Scottish programme in March 2019.³⁹

In May 2018, Defra consulted on environmental principles and accountability for the environment after the United Kingdom leaves the European Union.

The CCC responded to the consultation and wrote to the Secretary of State in July 2018, setting out the Committee’s view on some of the proposals.⁴⁰ The result of the consultation was the draft Environment (Principles and Governance) Bill, which sets out how the Government will maintain environmental standards as the UK leaves the EU.⁴¹ It also details plans to build on the vision of the 25 Year Environment Plan (25YEP). This includes creating an independent body - the Office for Environmental Protection (OEP) – which will scrutinise the Government’s environmental improvement plan (currently the 25YEP), investigate complaints about, and take enforcement action on, infringement of environmental law. The CCC has provided advice to Defra to ensure that the scope and workings of the OEP in scrutinising the 25YEP and enforcing environmental law work effectively alongside the requirements of the Climate Change Act and the remit of the CCC, especially on adaptation.

The CCC recommends that scrutiny of the 25YEP is based on clear and measurable objectives, which include appropriate consideration of the risks and opportunities from climate change, to

³⁸ The remainder recorded a ‘don’t know’ response.

³⁹ CCC (2019) *Final Assessment of Scotland’s first Climate Change Adaptation Programme*.

⁴⁰ CCC (2018) *Letter to Michael Gove – Environmental Principles and Governance after EU Exit consultation*.

⁴¹ HM Government (2018) *Draft Environment (Principles and Governance) Bill 2018*.

delivery of the plan's goals. Scrutiny of the Plan needs to assess to what extent actions are being taken to deliver the goals under climate change, and how these actions are affecting the resilience of the natural environment. We pick up on this theme in chapter 2.

1.4 The second UK Climate Change Risk Assessment

The second UK Climate Change Risk Assessment (CCRA2) identified 56 key risks and opportunities for the UK to address in the next five years. Thirty-eight were classed as 'more urgent' and 18 as 'less urgent'.⁴²

The 56 risks were based on the CCC's independent CCRA Evidence Report, published in 2016 and accepted by the Government (apart from the urgency of addressing the risks to food security) in its Government Report in 2017. Figure 1.3 shows how the CCRA risks are divided into different urgency categories. 'More action needed' and 'research priority' were classed as more urgent, requiring additional action or research in the next five years, while 'sustain current action' and 'watching brief' were classed as less urgent, requiring current actions and monitoring to be sustained.⁴³

1.5 The second National Adaptation Programme

The Government published the second National Adaptation Programme (NAP2) in 2018.⁴⁴

The NAP2 is the Government's response to CCRA2 and should set out what the Government and others will be doing over the next 5 years to manage the risks and opportunities identified in the latest assessment. The Adaptation Committee then assesses progress on this basis.

We published our initial high-level views on NAP2 in a blog post in July 2018.

We noted some positive improvements on the first programme but also some key gaps relating to some of the more urgent climate change risks.⁴⁵ Positive features included the introduction of a set of objectives, actions and owners in the new programme and commentary on dealing with uncertainty. Further, all of the main groups of risks highlighted in CCRA2 are mentioned in the opening pages of the NAP - flooding and coastal change, high temperatures, water shortages, food security, risks to natural capital, and pests and diseases. However, there are gaps in the coverage of the more urgent (more action needed and research priority) risks in the list of actions in the report.

We also noted a lack of measurable success criteria with associated timescales. Apart from a column on monitoring and metrics in the NAP annex, there is no discussion on monitoring and evaluation, areas which we conclude are even weaker than for the first NAP.

Of the 56 risks and opportunities we have previously identified, 21 are not covered by formal NAP actions, including 13 more urgent risks.

The coverage of CCRA risks and opportunities in NAP2 is shown in Figure 1.3. The blue boxes show where there are formal actions somewhere in the NAP, but not the relevance and effectiveness of those actions; this is picked up in our sectoral chapters 2 – 5.

⁴² CCC (2016) *UK Climate Change Risk Assessment 2017: Evidence Report*.

⁴³ See Chapter 2 of the CCRA2 Evidence Report for more details of the urgency scoring methodology used, and definitions of the urgency categories.

⁴⁴ HM Government (2018) *The National Adaptation Programme and the third strategy for climate adaptation reporting*.

⁴⁵ Kathryn Brown for the CCC (2018) *Blog post: The new National Adaptation Programme: Hit or miss?*

No explanation is given in NAP2 for the omissions (grey and yellow boxes), which is of particular concern for those risks and opportunities classed as more urgent (more action needed, or research priority).

Figure 1.3. Risks and opportunities for the UK identified in the 2016 CCRA Evidence Report, and their coverage in NAP2

MORE URGENT		LESS URGENT	
MORE ACTION NEEDED	RESEARCH PRIORITY	SUSTAIN CURRENT ACTION	WATCHING BRIEF
Ne1: Risks to species and habitats from changing climate space	Ne3: Changes in suitability of land for agriculture and forests	Ne9: Risks to agriculture, forestry, landscapes and wildlife from pests/pathogens/invasive species	Ne14: Risks & opportunities from changes in landscape character
Ne2: Opportunities from new species colonisations	Ne7: Risks to freshwater species from high water temperatures	Ne10: Extreme weather/wildfire risks to farming, forestry, wildlife and heritage	In7: Low/high river flow risks to hydroelectric generation
Ne4: Risks to soils from increased seasonal aridity and wetness	Ne13: Ocean acidification & higher water temperature risks for marine species, fisheries and heritage	Ne11: Saltwater intrusion risks to aquifers, farmland & habitats	In8: Subsidence risks to buried/surface infrastructure
Ne5: Risks to natural carbon stores & carbon sequestration	In5: Risks to bridges and pipelines from high river flows / erosion	In13: Extreme heat risks to rail, road, ICT and energy infrastructure	In10: Risks to electricity generation from drought and low flows
Ne6: Risks to agriculture & wildlife from water scarcity & flooding	In11: Risks to energy, transport & ICT from high winds & lightning	In14: Benefits for infrastructure from reduced cold events	PB3: Opportunities for increased outdoor activity in warmer weather
Ne8: Risks of land management practices exacerbating flooding	In12: Risks to offshore infrastructure from storms and high waves	PB13: Risks to health from poor water quality	PB12: Risks of food-borne disease cases and outbreaks
Ne12: Risks to coastal habitats & heritage from sea level rise, loss of natural flood protection	PB2: Risks to passengers from high temperatures on public transport	PB14: Risk of household water supply interruptions	Bu4: Risks to business from reduced access to capital
In1: Risks of cascading infrastructure failures across interdependent networks	PB6: Risks to the viability of coastal communities from sea level rise	Bu3: Risks to business operations from water scarcity	Bu7: Business risks /opportunities from changing demand for goods & services
In2: Risks to infrastructure from river, surface/ groundwater flooding	PB7: Risks to fabric of buildings from moisture, wind, rain	Bu6: Risks to business from disruption to supply chains	It7: Opportunities from changes in international trade routes
In3: Risks to infrastructure from coastal flooding and erosion	PB8: Risks to culturally valued structures and historic environment		
In4: Risks of sewer flooding due to heavy rainfall	PB10: Risks to health from changes in air quality		
In6: Risks to transport networks from embankment failure	PB11: Risks to health from vector-borne diseases		
In9: Risks to public water supplies from drought and low river flows	Bu2: Risks to business from loss of coastal locations and infrastructure		
PB1: Risks to public health and wellbeing from high temperatures	Bu5: Employee productivity impacts in heatwaves and from severe weather infrastructure disruption		
PB4: Potential benefits to health and wellbeing from reduced cold	It2: Imported food safety risks		
PB5: Risks to people, communities & buildings from flooding	It3: Long-term changes in global food production		
PB9: Risks to health and social care delivery from extreme weather	It5: Risks to the UK from international violent conflict		
Bu1: Risks to business sites from flooding	It6: Risks to international law and governance		
It1: Weather-related shocks to global food production and trade			
It4: Risks from climate-related international human displacement			

KEY :

Included in NAP2 with relevant actions

Mentioned in NAP2, but no formal actions

Not mentioned anywhere in NAP2

Source: CCC (2016) *UK Climate Change Risk Assessment 2017 Synthesis report: priorities for the next five years*, Figure SR2.

Notes: Box colours show to what extent the risks and opportunities are covered in NAP2.

In other cases, where CCRA2 identified that more action (over and above the current effort) was needed to address a risk, the actions the Government identifies in NAP2 are not new or strengthened.

Many of the actions in NAP2 are based on work that has been underway for several years. There is no explanation of how those existing actions have been strengthened to account for the recommendations in CCRA2 that more action or research is needed for the 'more urgent' risks and opportunities.

A number of overarching recommendations made by the Committee in our 2017 progress report have not been addressed adequately in the second NAP.

In particular, the NAP has not addressed recommendation 1; the objectives and associated actions are not SMART (specific, measurable, attainable, relevant and time-based) in many cases, and the NAP does not prioritise effectively a core set of actions that will have the biggest impact (Box 1.1).

The way the NAP2 document is written displays inconsistencies and gaps.

Some of the actions mentioned in the NAP2 chapters are not included in the list of formal actions in the annex. These include measures to manage the risks to passengers associated with high temperatures on public transport, and the review and update of climate change and health research strategies to ensure CCRA2 research priorities are addressed, including air quality and vector-borne pathogens. Some key adaptation policies (such as Flood Re) are not mentioned at all, and there is no consideration of international risks (see Section 1.8). The gaps and inconsistencies in NAP2 may be due in part to the lack of resource in Defra's climate change team.

Box 1.1. Overarching recommendations by the Adaptation Committee 2017 Progress Report, not addressed in the second National Adaptation Programme

PREVIOUS RECOMMENDATION 1: To ensure that activity and investments have a significant, cost-effective impact on reducing vulnerabilities, the second NAP should:

- **set clear priorities for adaptation;**
- **ensure objectives are outcome-focused, measurable, time-bound and have clear ownership;**
- **prioritise the core set of policies and actions that will have the biggest impact;**
- **build on the breadth of community and business engagement in the first NAP; and**
- **Include effective monitoring and evaluation.**

NAP2, like NAP1 has been built around a large collection of actions offered up from other government departments, arms' length bodies and other public-sector organisations. The priority risks from CCRA2 are mentioned in the introduction, but this is not followed through by a strategic statement of aims or setting out of ambition for dealing with the gaps in adaptation identified in CCRA2. The vast majority of objectives in NAP2 are not SMART, and there is a lack of consideration of how success will be measured.

PREVIOUS RECOMMENDATION 2: The second NAP should address the important interdependencies between climate change risks and policy responses which fall within and across the remits of different government departments, and national, local and devolved governments, to ensure relevant policies and activity are coordinated across the programme.

Treatment of interdependent risks remains a significant policy gap. The CCC and other bodies, such as the National Infrastructure Commission, are conducting further work on interacting risks and resilience that will inform the third CCRA (see chapter 4).

Box 1.1. Overarching recommendations by the Adaptation Committee 2017 Progress Report, not addressed in the second National Adaptation Programme

PREVIOUS RECOMMENDATION 3: To ensure continuous improvement in the approach to reducing climate change risks, the second NAP should have a strong focus on evidence and evaluation:

- there is the need and opportunity to work through UK Research and Innovation (UKRI) and the individual research councils to develop the evidence base in time to inform the third UK Climate Change Risk Assessment in 2022, making full use of the new UK Climate Projections in 2018;
- more attention needs to be paid to the evaluation of existing policies and approaches in order to learn lessons for future initiatives; and
- the costs and benefits of more ambitious policy options need to be considered and appraised.

While there is a positive focus on ongoing research and learning, including through the UKRI strategic priorities fund, the actions in NAP2 have not been built around an assessment of the costs and benefits of actions to meet strategic goals, and there is no consideration of when more transformational adaptation responses might be needed in the future.

PREVIOUS RECOMMENDATION 4: The Government should explore cost-effective ways to communicate the risks from climate change, and the actions that can be taken to reduce vulnerabilities. Priorities include:

- engaging vulnerable groups and communities exposed to specific risks such as higher temperatures, coastal change, and increases in flood risk;
- challenging the relevant professional bodies (such as the Landscape Institute, the Royal Town Planning Institute, and the Institution of Civil Engineers), and trade associations (for example the National Federation of Builders), to increase their level of engagement with members regarding climate change, and to improve the training, guidance and professional accreditation they offer; and
- raising awareness amongst the general public including through community groups and national membership organisations such as the National Trust, the Royal Horticultural Society, and the RSPB.

NAP2 has a stronger acknowledgement of the need to communicate climate change risks to the public in the introduction; but this does not flow through into actions to improve coordination of climate change communications, or on who should lead on the communication and what should be communicated. The actions related to communication are included only as they have been offered up by other organisations.

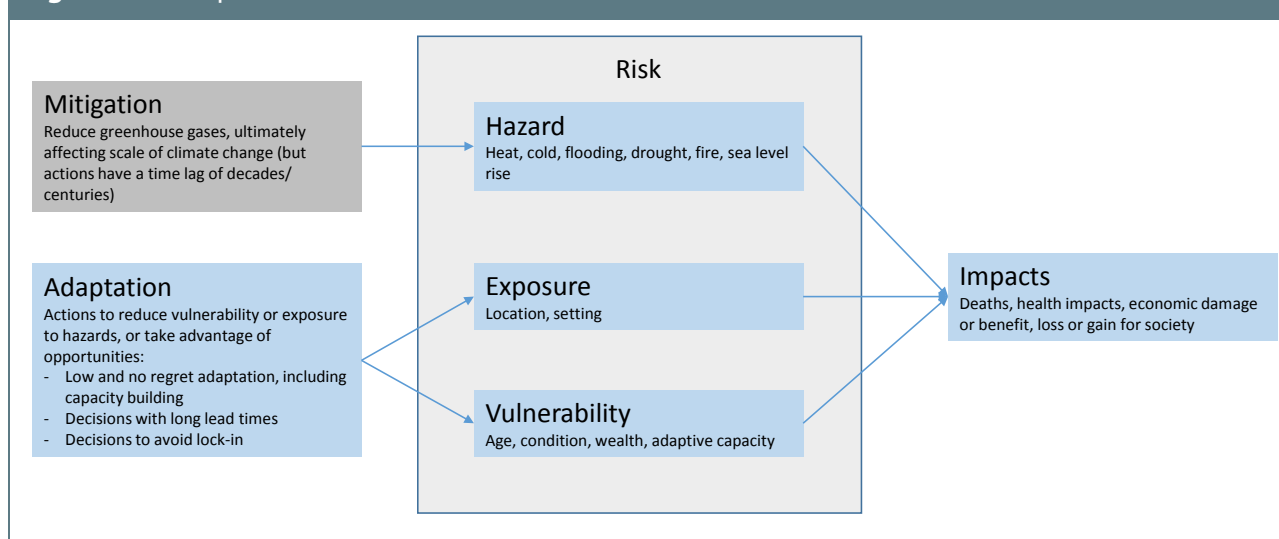
Source: CCC (2017) *2017 Report to Parliament – Progress in preparing for climate change*.

1.6 Approach to evaluating the second National Adaptation Programme

In order to assess progress in adapting to climate change in England, the Adaptation Committee has since 2012 used an evaluation method based on a two-part framework:

- (a) **Indicator framework:** the Committee collects indicators to assess trends in risk factors: hazard, vulnerability and exposure. We also collect indicators to assess trends in adaptation action, and impacts (Figure 1.4).
- (b) **Decision making analysis:** We assess the extent to which planning for climate change is taking place, including whether climate-sensitive plans and policies are adequately considering the risks and opportunities from climate change.

Figure 1.4. Adaptation Committee's indicator framework



Source: CCC.

Notes: Blue boxes denote aspects of risk and adaptation that are measured by the Adaptation Committee. Adaptation actions either reduce exposure or vulnerability, but do not have an effect on hazard (this is influenced by how successful mitigation efforts are). Positive or negative social, economic or environmental impacts provide an indication of how risk is changing, and the effectiveness of adaptation actions. Definitions of hazard, exposure and vulnerability used here are consistent with IPCC terminology from its Fifth Assessment Report (<https://www.ipcc.ch/report/ar5/syr/>).

Traditional indicators of change that are used in many sectors record how impacts on society and the economy change over time.

Relying on impact indicators for assessing adaptation progress is challenging, as it is difficult to distinguish year to year variability from long-term trends, and it is also difficult to attribute the changes in impacts to different drivers - for example whether the driver is a change in hazard or the result of adaptation actions. In addition, the effects of climate change mitigation and adaptation will interact with other pressures such as population and demographic shifts, economic changes, or land use change.⁴⁶

The Committee considers attributed impact indicators to have the greatest potential use in the long-term, but they only robust enough to be used if there is a sufficiently long record (multi-

⁴⁶ CCC 2011), *Adapting to climate change in the UK: Measuring Progress*.

decadal at least) and/or it is possible to isolate the effects of climate change from other pressures. The Committee expects that attributing changes in impacts to changes in climate and to adaptation actions should become more feasible over time and that efforts to do this will be important for directing efficient and effective adaptation actions. The science here is difficult, but improving. For example, the ability to attribute different weather events and their impacts to climate change is maturing. We report on attributed impact indicators in this report where possible and relevant.

The Committee's shorter-term objective is to understand the extent to which adaptation is reducing exposure and vulnerability to climate change impacts.

The components of climate risk are divided into hazard, vulnerability (including adaptive capacity) and exposure.⁴⁷ Some aspects of risk are driven by wider socio-economic factors (e.g. England's ageing population) which we term contextual. Other aspects of risk can be addressed through adaptation, such as the extent of development in areas prone to flooding (we term these 'controllable'). Indicators to track trends in vulnerability and exposure to risk provide a baseline against which adaptation outcomes can be measured.

To understand the trends in exposure and vulnerability to climate change, we also consider what actions are taking place, and what impact these are having.

These aspects of adaptation action help to inform the CCC about where adaptation is acting to reduce risk, and where there are adaptation gaps. Box 1.2 shows an example of the range of indicators we use to assess progress in managing flood risk, which is one of the few adaptation areas where we have a good set of indicators of different types (though there are still gaps, particularly in relation to surface water flooding).

The Committee wants to reach a point where we are able to populate all types of indicators across all of our adaptation priorities. For some adaptation priorities, such as the ICT, telecoms and digital sector, we currently have no indicators at all.

It is important to note that some indicators can belong to one or more categories above.

For example, if there is evidence that populations of wetland birds are being affected by climate change, changes in the population abundance can be used as a climate change impact indicator. However, population abundance can also be used as a vulnerability indicator, even in the absence of any causal effect of climate change. This is because smaller, less diverse populations of wetland birds are likely to be less resilient to future climate change, regardless of what is driving current population trends. Looking at the examples in Box 1.2, the proportion of urban area that is made up of impermeable surfacing is a vulnerability indicator, while a very similar metric, the uptake of permeable surfacing, is an action indicator. Where appropriate, we explain through this report which type of indicator we are using.

⁴⁷ Definitions for each of these can be found in the latest UK Climate Change Risk Assessment Evidence Report.

Box 1.2. Example of the types of Adaptation Indicators - Flooding

Managing flood risk in England is an example of an adaptation priority where we have fairly robust indicators across all of our indicator categories:

Hazard: Extent of floodplain under 2°C and 4°C scenarios.

Exposure: Number of people living in areas of flood risk; number of residential properties located in areas of flood risk (accounting for, or not accounting for flood defences)

Vulnerability: Proportion of urban areas made up of impermeable surfacing; number of properties with property-level flood resilience; number of people living in flood risk areas who are unaware that they are located in an at-risk area; proportion of flood defences that are maintained in line with target condition.

Action: Annual expenditure on flood risk management; uptake of property-level flood resilience; uptake of green sustainable drainage systems in new and existing developments; uptake of permeable paving; number of flood insurance policies that are reinsured by Flood Re.

Impact: Number of people or properties that are flooded per year; number of people suffering mental health impacts from flooding; length of time between being flooded and people returning to their homes.

Source: CCC.

The Committee aims to understand how adaptation actions are affecting vulnerability and exposure, but in many cases there is currently insufficient evidence for the effect of adaptation to be assessed.

To understand whether adaptation is effective, we would need to be able to see how the actions being taken are reducing vulnerability or exposure, or taking advantage of opportunities. For example, we want to understand how restoration of habitats is affecting the sensitivity of the natural assets and services in those habitats to specific climate hazards. At present, the information available does not allow us to attribute changes in vulnerability or exposure to specific adaptation actions, and sometimes changes may be due to pressures other than climate change. In the case of the natural environment, there will often be a time lag between an action, and the resulting reduction in vulnerability or exposure. For example, it can take years between a restoration activity and any evident improvement in habitat condition. Where we do not have evidence to attribute the effects of adaptation on risk, we make assumptions about the likely effects of adaptation. Reporting on changes in vulnerability and exposure may still provide valuable information about the level of risk, even though it is difficult to identify what is driving that change.

The Adaptation Committee has applied its decision making and indicator framework across 33 defined 'adaptation priorities' that cover the categories of climate risk set out in CCRA2.

Using this framework, the Adaptation Committee asks two questions in relation to each priority, considering both what is in the NAP2 and other activity underway:

- ***Is there a good quality plan?*** The Committee has reviewed whether plans are in place that include a consideration of climate change adaptation and assessed whether plans are SMART – specific, measurable, attainable, relevant and time-bound. A good plan will have clearly stated outcomes that are appropriate in the context of climate change, have considered the short-term and long-term effects of climate change including how risk is likely to increase in future under 2°C and 4°C scenarios, have an effective monitoring and evaluation framework and demonstrate clear links between the outcomes and corresponding actions. A weaker plan might have vague or unclear outcomes, make weaker links to the current and future effects of climate change, and may only include guidance but not require specific action.
- ***Is progress being made in managing risk?*** The Committee has populated the indicator framework described above with best available data and also reviewed relevant action underway in the NAP and elsewhere, assessed how risk is changing, and whether goals remain on track to be met where this is relevant. In this context, the Committee has considered to what extent the actions taking place relate to the risks identified in the Climate Change Risk Assessment and whether they are being implemented in accordance with NAP2. The assessment seeks evidence of what impact the actions are having on risk, wherever possible.

Our assessment framework (Box 1.3), which has been updated since our last independent assessment of the NAP, has revised the scoring of progress against adaptation priorities into a ranked score that reflects the quality of plans, and how risk is changing.

While the delivery of actions is important, in this revised scoring system the assessment of action is tied more closely to whether there is a subsequent impact on risk, compared to the Committee's previous framework. Each adaptation priority is given a numerical score, based on the criteria set out in Table 1.1; one being the lowest score and nine the highest.⁴⁸ We have given scores on this basis to each adaptation priority (see executive summary and each chapter), and will update these scores in our next report in 2021.

⁴⁸ In previous assessments, each adaptation priority was given a score of either Red, Amber, Green or Grey for each of the following three questions: 'is there a plan', 'are actions taking place' and 'is progress being made in managing vulnerability'?

Box 1.3. The Adaptation Committee's Assessment Framework



Source: CCC.

Notes: The y-axis scores each adaptation priority on the quality of plan in place to address climate change risks. The x-axis scores each adaptation priority on the extent to which progress is being made in managing vulnerability and exposure to climate change risks. The result is a numerical score (1-9) for each adaptation priority. Where there is insufficient evidence to assess progress in managing vulnerability or exposure, the priority is rated as low progress on the x axis. The Committee has given slightly more weight to having a good plan compared to having evidence of managing risk in this framework (e.g. a medium quality plan with low progress in managing risk scores a three, while a low quality plan with mixed progress in managing risk scores a two).

Table 1.1. Adaptation Committee assessment criteria		
Score	Plan score	Risk score
High	Good quality plan: Considers climate change, including a range of scenarios Sets out specific action – not just guidance SMART – specific, measurable goals with timescales Has effective monitoring and evaluation built in Can see links from the plan down to the actions Plans up to date	Evidence that risk (vulnerability and exposure) is reducing at an appropriate rate, and/or is in line to meet goals Good evidence of impact of actions on risks
Medium	Medium quality plan: Considers climate change, though possibly vague on what scenarios are included Requires general action – not just guidance Some aspects of being SMART Some monitoring and evaluation Some links to action	Mixed picture – some evidence of risk being managed, but other areas where progress is lacking Some evidence of impact of actions on risks
Low	Low quality plan: Minimal or no consideration of climate change No firm actions, not SMART No monitoring and evaluation No firm link through to actions Plans not up to date	Evidence that risk is not reducing or is increasing, or lack of evidence to judge what is happening to risk No evidence that actions are having an impact on risk
Source: CCC. Notes: Bold criteria are considered as key to that score; other criteria are also assessed but are of lesser importance.		

1.7 Structure of this report

The analysis in this report largely follows the structure of NAP2.

There are separate chapters for the NAP themes of Natural Environment (Chapter 2), People and the Built Environment (Chapter 3), Infrastructure (Chapter 4) and Business (Chapter 5). Unlike the NAP there is no separate local government chapter, because local government is an actor in addressing the risks in the other chapters rather than a separate set of priorities, so the assessment of each of the themes above considers the role and actions of local government, where relevant.

Each chapter includes:

- a summary of the relevant climate change risks for that theme;
- an overview of the theme and objectives, and related adaptation priorities defined by the Adaptation Committee; and
- for each adaptation priority:
 - an overall score using the criteria set out above,
 - an assessment of plans in NAP2 and elsewhere that are in place; and
 - an assessment of progress through NAP2 and elsewhere in managing risk.

1.8 International Dimensions from CCRA2

There are no NAP2 actions that address the risks that the UK faces from the international impacts of climate change.

The Committee would like to express its concern that international risks are not addressed in NAP2. CCRA2 considered how international climate risks would directly and indirectly impact the UK as shown in Figure 1.2. The inclusion of an international chapter was an extension to the scope of CCRA1, which focused solely on risks from climate change impacts in the UK. CCRA3 will also examine these international risks, as they are becoming increasingly significant.

The elements of international risks that are especially relevant to the UK, identified by CCRA2, fall into the following categories: (1) global trade and supply chains, especially for food; (2) migration and displacement; and (3) broader geopolitical and macroeconomic issues. In particular, the CCRA2 Evidence Report assessed that extreme weather events have the potential to affect global food production, trade and supply chains, making prices more volatile and/or altering productivity in the long-term. Further, weather-related events were identified as potential drivers of increased international human displacement with subsequent impacts on overseas development efforts. These risks were assigned to the 'more action needed' category.

However, the formal NAP2 actions do not cover any of the international risks from CCRA2.⁴⁹ We have, therefore, not included an International Dimensions chapter in this Progress Report as there are no NAP actions against which to assess progress.

⁴⁹ Food supply is implicitly addressed as a Critical National Infrastructure sector and within the associated annual Sector Resilience plan. Other international risks are mentioned in the NAP text but are not assigned any actions.

Chapter 2: Natural Environment



2.1. Introduction

This chapter considers progress in adapting the natural environment to climate change; including both natural capital assets, and the goods and services they provide.⁵⁰

As for our previous progress reports, the natural environment chapter covers a hierarchy of adaptation priorities that relate to the protection of habitats and species. These include a range of natural assets, including biodiversity, through to regulating and provisioning services. Table 2.1 below sets out the priorities covered and their place in this natural capital framework. Soil quality and carbon sequestration are further important underpinning regulating services, however, they are especially difficult to separate out from the other priorities, so are picked up within each of the other adaptation priorities.

Table 2.1. Natural environment chapter adaptation priorities

Natural capital assets including biodiversity	Regulating services	Provisioning services
Terrestrial habitats and species Freshwater habitats and species Marine and coastal habitats and species Farmland habitats and species	Water management	Agricultural productivity Commercial forestry Commercial fisheries and aquaculture
Notes: The structure of this chapter follows the Natural environment and natural assets chapter in the Evidence Report for the 2017 UK Climate Change Risk Assessment. Its focus is the protection of the natural environment (which is a subset of total natural capital) and goods and services that are provided directly from land, water and sea. For example, the business chapter covers a range of other provisioning services (minerals, energy); flood regulatory services are also covered in the infrastructure chapter; while water appears in several chapters across the report. Biodiversity cuts across all aspects of natural capital, but for the purposes of reporting it is included mainly in the habitats and species sections of this chapter. Cultural services are not included in this discussion.		

This chapter covers natural capital assets and the goods and services that are mostly delivered within the natural environment. However, it should be noted that other goods and services are discussed elsewhere in this report in the relevant chapter.

The goods and services provided to people by the natural environment are covered throughout this report, including flood hazard regulation, water quantity and quality, food provision and climate regulation (cooling). It is impossible to structure the report in a way that places all of these goods and services together in one place, as they cut across the majority of climate risks. This chapter presents analysis for those goods and services that are mostly delivered within the natural environment (water regulation, food and timber production). The people, infrastructure and business chapters cover flooding, cooling, pests and diseases, and water availability for people in more detail.

⁵⁰ The Natural Capital Committee (NCC) defines natural capital as 'those elements of the natural environment which provide valuable goods and services to people, such as the stock of forests, water, land, minerals and oceans'.

This chapter makes the case for moving away from the more simplistic assessment of the vulnerability, and exposure of the natural environment and biodiversity to climate change that we have produced in previous progress reports. More sophisticated approaches are needed to develop, implement, and test adaptation metrics.

These are needed to tell us more clearly how ecosystems and biodiversity are changing as a result of climate change, and the components or functions that are most vulnerable to climate change, so that adaptation responses can be better focussed.

Our previous reports have measured the vulnerability of biodiversity to climate change based on the principles set out in the Lawton Review (2010). The high level findings of the review suggested that habitats need to be in good condition, bigger, and more joined up in order to have a greater chance of allowing the species they support to adapt naturally as the climate changes.⁵¹ Most of our current indicators of risk are based around these principles, particularly condition data for habitats. We attempt to use habitat condition and species abundance (whether impacted by climate change or not) as proxy indicators for the vulnerability of biodiversity as a whole, as they give a sense of how ‘under pressure’ different systems already are (based on the idea in the Lawton Review that ecosystems will withstand the risks from climate change more effectively if other pressures on them are reduced).

However, climate change will impact species and ecosystems in many ways. Changes in prevailing weather conditions (temperature, precipitation, seasonality) directly affect ecosystem processes as well as species survival and/or reproductive success. Species are also affected indirectly when climate change influences their predators, prey and other food sources, pathogens, breeding sites, nesting sites or migration routes, and can cause disruptions to the timing of life cycle events (phenology). There are many lines of evidence that show that species are already being affected by climate change.⁵²

New methods are needed, therefore, to measure underlying vulnerability and track the effects of climate change, to design metrics and indicators, and to implement effective actions to protect species and their habitats that focus on where species and habitats are most sensitive to climate change. Such adaptation methods and metrics are becoming increasingly important but currently lag well behind climate change mitigation metrics in both design and development, in part because of their inherent complexity.⁵³

The development of practical and robust metrics for the impacts of climate change on species and ecosystems, and for assessing the effectiveness of interventions, is a priority. While there are many challenges, there has been progress in recent years in both disaggregating climate change impacts from the effects of other pressures such as land use⁵⁴, as well as methods for modelling future population trends for species given known trends in climate suitability.⁵⁵

⁵¹ See a fuller description of the Lawton principles in CCC (2013) *Managing the land in a changing climate*.

⁵² Urban, M.C. (2015) *Accelerating extinction risk from climate change*. *Science*, 348(6234), pp.571-573.

⁵³ Noble, I.R., et al. (2014) *Adaptation needs and options*. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 833-868.

⁵⁴ Eglington, S.M. and Pearce-Higgins, J.W. (2012) *Disentangling the relative importance of changes in climate and land-use intensity in driving recent bird population trends*. *PloS one*, 7(3), p.e30407.

25-year Environment Plan Outcome Indicator Framework

The Government's 25-Year Environment Plan (hereafter referred to as the 25-year Plan) sets out an aim to "be the first generation to leave the environment in a better state than we inherited it".⁵⁶ This is an ambitious vision for future environmental quality. Notably, the plan contains commitments to recognise good practices that build up and bolster natural assets, such as soil, water and biodiversity, whilst also taking account of the negative effects of a range of current land uses and activities. Achieving the ambitions outlined in the 25-year Plan will require a balance of incentives and regulations – influencing decisions on the way land is used.

The Government has published a framework of outcome indicators to accompany the 25-year Plan. The framework contains 66 indicators, arranged into 10 broad themes. Adaptation is defined within the framework as: "how the natural system is responding to climate change impacts". This implies that adaptation is a feature of a given natural system rather than it being an outcome for society, the economy or the natural environment. Furthermore, while the framework contains a large number of indicators, none of them allow climate change impacts to be identified from other factors, and none allow the effectiveness of adaptation actions that might reduce those impacts to be identified.

The Government has put a number of new Bills before Parliament that will replace existing environmental legislation arising from our membership of the EU. These have impacts across all of the adaptation priorities in this chapter so are summarised here.

Environment Bill

The draft Environment (Principles and Governance) Bill sets out how the government will maintain environmental standards as the UK leaves the EU. It also details how the Government will build on the vision of the 25-year Plan, and it is expected that the version that is brought to Parliament in mid-2019 will have a section on a framework for environmental targets, alongside the existing sections on governance and principles. The Bill includes provisions for the creation of an Office for Environmental Protection (OEP), an independent body that will have responsibilities to: scrutinise environmental law and the Government's environmental improvement plan (EIP - currently the 25-year Plan); investigate complaints; and take enforcement action on environmental law. The draft Bill commits the Government to publishing a policy statement that will set out how Ministers should interpret and apply environmental principles. It also commits the Government to have a plan for environmental improvement, currently the 25-year Plan.

Agricultural Bill

The Agriculture Bill is the legislative framework for a seven-year (2021 to 2027) agricultural transition period as the UK moves from the current Common Agricultural Policy (CAP) arrangements towards a new 'public money for public goods' approach to future environmental land management support schemes in England and Wales. Part 1 gives the Secretary of State new powers to provide financial assistance to those managing the land and delivering public benefits such as air and water quality, public access and productivity.

⁵⁶ Defra (2018) *A Green Future: Our 25 Year Plan to Improve the Environment*.

Fisheries Bill

This framework Bill is intended to replace the EU's Common Fisheries Policy (CFP). It aims to create a domestic fisheries policy governing foreign access to British fishing grounds, the licensing of fishing boats, and grants connected to fishing. The Bill also extends the powers of national authorities with regard to marine conservation to the whole of the UK Economic Exclusion Zone (EEZ). The Bill will provide the UK with powers to set annual total allowable catches for UK waters, and give the UK Government and devolved administrations powers to amend the fisheries regulations that will be transposed into UK law from EU legislation.

2.2. Terrestrial habitats and species

This adaptation priority covers semi-natural habitats classed by Natural England as terrestrial - woodlands, grasslands, heath, montane habitats, fens and bogs. We assess progress in adaptation as related to the changing condition and size of the habitats, but condition data is only available for Sites of Special Scientific Interest (SSSIs)⁵⁷, which are a small percentage of the overall area of terrestrial habitats. We consider trees in terms of woodland habitats here, but as a commercial good in section 2.8. Better indicators for assessing progress for terrestrial habitats and species would include soil organic carbon (SOC) and biota levels; soil erosion rates; and changes in abundance and distribution of climate sensitive terrestrial species.

What is the risk?

CCRA2 notes that shifts in the spatial range for species and changes in phenology will have implications for the ecological composition of ecological communities and habitats, with both winners and losers.

The scale of change will depend heavily on the ability of species to disperse physically and adapt to changes in average temperatures, rainfall patterns and seasonality. Species will only be able to adapt autonomously to changing climatic conditions if there is a coherent network of habitats available to them that are in a good ecological condition.

With regard to peatlands, warmer and drier conditions could have adverse implications for the viability of already stressed peatland habitats and their species, particularly bryophytes (mosses and liverworts). Peatlands on the eastern side of the UK are at higher risk from climate change, particularly where they are already vulnerable due to drainage and adverse management practices. CCRA2 emphasised the need for further action to improve the condition of degraded soils, better protect soils from damaging practices and encourage the wider uptake of soil conservation. To support this, long-term monitoring of soil condition, in terms of SOC levels, erosion rates and soil biota is also required.

CCRA2 also identified a need for increased action now and into the future to reduce existing pressures on terrestrial habitats and species; improve the ecological condition of protected wildlife sites; and restore degraded ecosystems, such as peatlands and native woodlands.

⁵⁷ Also referred to as 'designated sites'.

CCC progress score	Reason for progress score
3	Plan score - medium: Plans for protecting terrestrial habitats, including peatlands, contain targets, which if met, would go a long way to reducing vulnerability to climate change. However, they do not include a specific set of actions to meet the goal, and do not consider the long-term implications of climate change, including a substantial threat of lock-in to irreversible change. Risk score - low: • Available indicators of the vulnerability of terrestrial habitats and species suggest the targets set out in the Government's Biodiversity 2020 strategy will not be met. • Only around one quarter of terrestrial SSSIs are in favourable condition. • The percentage of upland blanket bog sites in favourable condition has dropped further from 19% in 2003 to 12% in 2018. • Efforts to increase the size of semi-natural woodland habitats are off track, though some progress appears to have been made in improving connectivity. • Woodland species indicators show long-term declines for birds and butterflies.

Is there a good quality plan?

Plans outlined in NAP2 for improving the condition of terrestrial habitats and species are limited to protected sites, lack deadlines, are not linked to specific actions and do not include explicit consideration of climate change.

Are plans covered in NAP2?

In its response to our 2017 recommendation (no.6), the Government agreed that action should be taken to enhance the condition of priority habitats⁵⁸ and the abundance and range of priority species, both on protected sites and in the wider countryside. As mentioned above, maintaining and improving the condition of all conservation areas and the wider countryside is an important adaptation goal as set out in the Lawton Review (2010).

NAP2 references the Government's target to restore 75% of terrestrial protected sites⁵⁹ in England to a favourable condition⁶⁰ to support the achievement of its goal outlined in its 25-year

⁵⁸ 'Priority habitats' and 'priority species' were those that were identified as being the most threatened and requiring conservation action under the UK Biodiversity Action Plan (UK BAP). The original list of UK BAP priority habitats was created between 1995 and 1999, and was revised in 2007. Many priority habitat sites are also protected, through for example designation as Sites of Special Scientific Interest (SSSIs).

⁵⁹ The total extent of protected areas is comprised of: nationally designated sites (Sites of Special Scientific Interest - SSSI), National Nature Reserves (NNR), and internationally designated sites (Special Protection Areas - SPA) and Special Areas of Conservation (SAC)) under the European Union's Birds and Habitats Directives respectively and Ramsar sites under the Convention on Wetlands of International Importance.

⁶⁰ Achieving favourable condition status requires that protected sites and features are in a healthy state and are being conserved by appropriate management.

Plan of 'thriving plants and wildlife'. The total extent of land (including terrestrial and freshwater sites) protected in England is over one million hectares, representing about 8% of the land area.⁶¹ Restoring 75% to favourable condition is an increase to the ambition for terrestrial protected sites set out in the Biodiversity 2020 Strategy, which aims to achieve 50% in favourable condition. However, we have a number of concerns:

- there is no set deadline for meeting the 25-year Plan goal - so we assume for the purposes of this report that the end point is 2043 (25 years from 2018);
- the Plan lacks an explicit consideration of actions that are required to meet this goal, including in the context of climate change, which will almost certainly make it harder to achieve or may require different actions in different areas;
- the Plan does not consider how progress can be assessed effectively; and
- in its current form, the 75% restoration target falls well short of the Government's response to the CCC's 2017 report⁶² in that it only applies to terrestrial protected sites - the target should be extended to include all priority terrestrial sites.

The 25-year Plan reiterates the aspiration included in the Natural Environment White Paper (2011) for all of England's soils to be managed sustainably by 2030. This scope is broader than the targets outlined in the Plan for terrestrial habitats, which, as stated above, only relate to 75% of protected sites. The 25-year Plan, however, lacks clear pathways to achieve this and is vague about how soil condition will be measured. For example, it contains no clear action in relation to schemes and proposals required to provide mitigation and adaptation benefits from soils. Furthermore, without clarity over what 'sustainably managed' means it will be difficult to determine whether the target has been achieved.

NAP2 states that a Peatland Strategy for England will also be published by the Government, although this has been delayed until the end of 2019. It is not clear at this stage the extent to which the Strategy will address the gaps in achieving the 25-year Plan goals for soil, or how relevant its content will be to climate change adaptation.

NAP2 also includes partial plans that consider how woodlands need to adapt to a changing climate (see also section 2.8). The Tree Health Resilience Strategy for England was published by the Government in 2018. The focus of the Strategy is to improve the capacity of woodlands to adapt to changing pressures (including climate change) through mitigating and minimising the impact of pests and diseases, as well as species and provenance choice.

The Strategy advocates the important adaptation goals set out in the Lawton Review (2010) of increasing the number, size, quality and connectivity of woodland in England, as priority objectives to address the urgent risks to woodlands outlined in the CCRA2.

NAP2 outlines Defra's plans to develop and implement a Nature Recovery Network (NRN), providing habitat restoration and creation along with improved access for people, flood protection and water quality. As also stated in the 25-year Plan, the ambition is to provide 500,000 hectares of additional wildlife habitat, more effectively linking existing protected sites and landscapes, as well as urban green and blue infrastructure. Natural England is leading work to explore how climate change considerations can be incorporated into the NRN's design, both

⁶¹ Defra (2018) *England biodiversity indicators: 1. Extent and condition of protected areas*.

⁶² In its response to recommendation 6 of the CCC's 2017 report to parliament, the Government recognised the need for action to be 'taken to enhance the condition of priority habitats and the abundance and range of priority species, both on protected sites and in the wider countryside'.

spatially and as a core principle. Development is currently at an early stage, though plans are underway to restart the NAP ecosystems and biodiversity group. This will be used as a platform to discuss with a wider group of partners, issues including potential impacts under 2°C and 4°C degree global temperature scenarios.

Are there other plans not mentioned in NAP2?

The UK Government has committed to retaining the level of ambition set out in EU legislation in the immediate-term following EU exit. However, draft clauses in the Environment Bill for restoration and recovery of terrestrial sites and species once it leaves the EU need to explicitly consider climate change impacts.

The EU Habitats and Birds Directives set out the means by which EU Member States will meet their international objectives for habitats and species as agreed under the Bern Convention. Many current UK laws, such as the Conservation of Habitats and Species Regulations 2017, make direct reference to compliance with these Directives. Any revisions to these laws for a UK-setting following departure from the EU will need to ensure the degree of protection currently provided is maintained. However, while current regulations provide a robust framework for building the ecosystem resilience required to adapt to climate change, the focus is on conservation and restoration with only limited consideration of actions to address the potential future impacts from climate change and associated risks.

As outlined above, the Office for Environmental Protection (OEP) will be tasked with scrutinising, assessing and providing advice on the Government's Environmental Improvement Plans (EIPs), which will include monitoring progress of EIPs and producing subsequent annual reports to Parliament. However, if the proposed EIPs are to achieve the 25-year Plan objectives for terrestrial species and habitats (and beyond) they need to include actions that explicitly consider climate change impacts and the resulting risks.

Do the plans address the risks in CCRA2?

The 25-year Plan does not contain the level of ambition required to effectively reduce the existing pressures on terrestrial habitats and species, as set out in CCRA2. The Plan lacks explicit actions and deadlines by which to complete the goals it contains, while the 75% restoration target only applies to protected terrestrial sites, and not broader priority terrestrial habitats. The Peatland Strategy and Nature Recovery Network should help to deliver further adaptation by improving the size and condition of terrestrial habitats. Both remain in development, providing an important opportunity for the long-term implications of climate change to be embedded within their respective frameworks.

Is progress being made in managing risk?

Are relevant actions taking place?

Actions to support soil health monitoring and the Peatland Strategy should help collectively to improve the resilience of terrestrial habitats, although most are still in the early stages of development.

NAP2 provides details on work currently underway to investigate how improved soil health can support the Government's wider environmental goals. Defra has funded a research project that investigates ways to address the lack of data to understand the current status of soils and the need to invest in soil monitoring.⁶³ The main aims of the research project are to:

- identify the current and anticipated policy questions that require an understanding of the changing health of our soils;
- develop a robust soil monitoring methodology, which collates and integrates multiple data sources at the appropriate scales required for answering key soil health policy questions; and
- develop a flexible soil monitoring methodology, which can allow further data inputs to meet future policy/end user needs.

Natural England and RSPB are in the process of updating their joint Climate Change Adaptation Manual. The potential impacts under 2°C and 4°C global temperature scenarios are not explicitly considered in the document. The revised manual has been written and is due to be released by autumn 2019.⁶⁴

In line with the NAP2 action to work collaboratively to develop candidate indicators and evidence summaries for tracking progress with adaptation actions, a workshop was held at Cambridge University in October 2018. The event brought together scientists, policy-makers, and conservation managers to inform the development of metrics (including indicators) to monitor and evaluate adaptation of the natural world to climate change. A report will be produced in autumn 2019, outlining the challenges and potential for developing indicators discussed at the meeting.

To support the achievement of targets for the reduction of peat use in horticulture, Defra has started informal discussions with retailers, growers, growing media manufacturers and non-government organisations on what potential further measures could look like. The project is in the initial stages of a process of discussion, consultation and evidence gathering.

The Government's commitment to maintain and expand current peatland restoration programmes in semi-natural habitats has been supported through a £10m peatland grant scheme, which commenced in 2018. The work is being delivered through four local partnership projects totalling an area of 6,580 hectares of upland and lowland peatlands, which represents around 1% of peatland areas in England.

Outside of the NAP actions, the National Trust is involved with a range of projects for the research, restoration and management of peatlands in England and Wales. The organisation has around 21,000 hectares of peatlands within its land assets. At present, it is intending to restore or create 3,269 hectares of peatland habitat, of which 2,070 hectares is underway and 665 hectares is complete.

⁶³ NAP action update – appendix A.

⁶⁴ NAP action update – appendix A.

Work to create a new Northern Forest has commenced. Rooted in the Government's goal for 'thriving plants and habitats', once fully implemented the forest will span 120 miles across the north of England and contain 50 million trees. The Woodland Trust, one of the organisations leading the initiative, has produced a Northern Forest manifesto, which includes explicit consideration of adaptation through ensuring suitable tree species are factored into spatial plans. Woodland Grant agreements are in place between Defra and the Northern Forest partnership and the first trees have been planted.⁶⁵

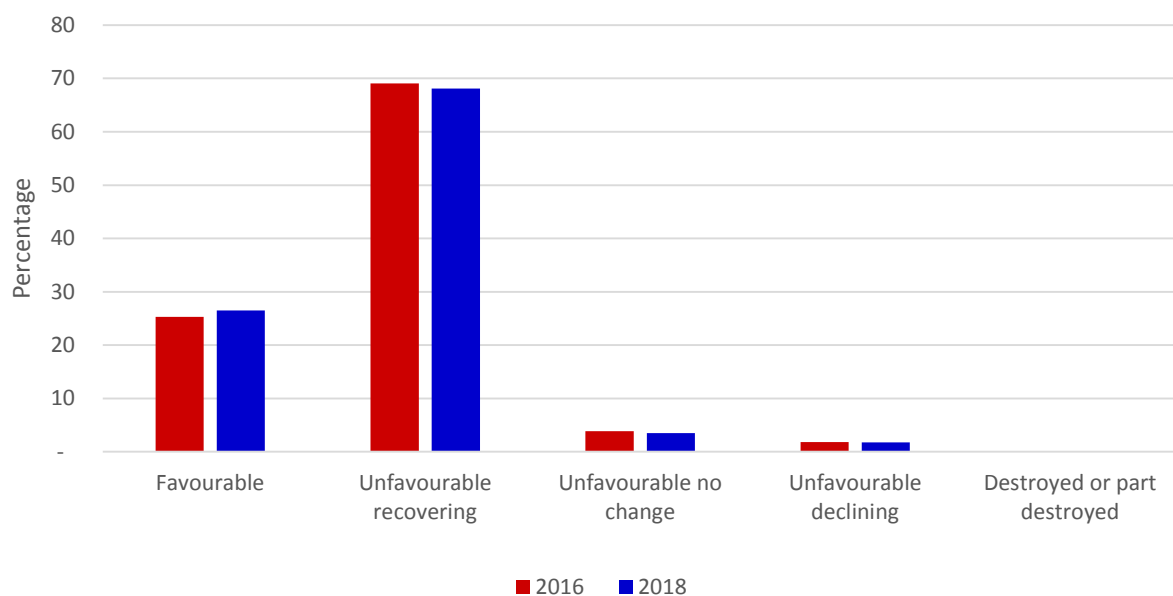
In line with pledges included in NAP2 to develop and start to implement a Nature Recovery Network, Defra has provided £140,000 in funding to test approaches to developing the landscape-scale network at six different locations across England.

Is there evidence that risk is being managed?

Available indicators of the vulnerability of terrestrial habitats and species indicate slow progress or a decline, suggesting the targets set out in the Government's Biodiversity 2020 strategy will not be met.

The proportion of terrestrial SSSIs in England classed as in either favourable or unfavourable recovering condition remained largely unchanged at 94% between 2016 and 2018 (figure 2.1). Despite a 2% rise between 2016 and 2018, only 27% of sites are classed as in favourable condition. As noted above, the ambition for terrestrial habitats set out in the Biodiversity 2020 Strategy is to achieve 50% in favourable condition, although this goal relates to protected sites of which SSSIs represent a sub-set.

Figure 2.1. Terrestrial SSSIs in England, by condition

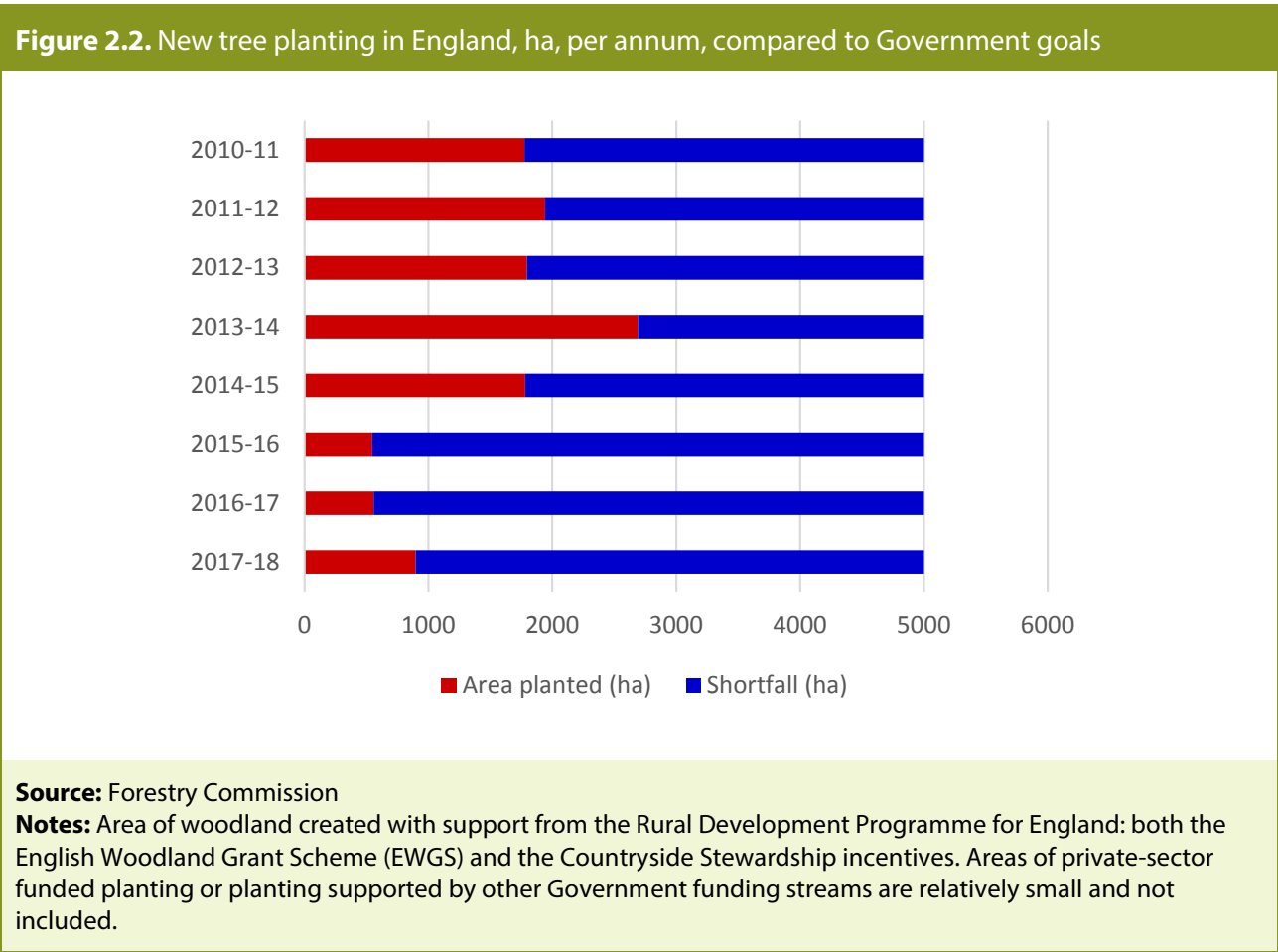


Source: Natural England,
<https://designatedsites.naturalengland.org.uk/NEInterimReports/ConditionByHabitat.aspx>

⁶⁵ NAP action update – appendix A.

Increasing the area of woodland in England could improve overall resilience of this habitat type to climate change, according to the Lawton Principles; though of course much also depends on whether other important habitats are being lost as a result. Our land use report (2018) showed that woodland planting is likely to be one of the best strategies for improving climate resilience, mitigation and wider co-benefits for biodiversity.⁶⁶

The Government’s aspiration to increase woodland cover in England to 12% of total land area by 2060, from the 10% cover at present, implies planting rates of at least 5,000 hectares per year (see section 2.8). NAP2 also reaffirms the 5,000 hectares goal for new woodland (including new native woodland priority habitat) per year in England. Despite this, annual planting rates from the Forestry Commission are sporadic and show that in no year has the annual target been reached (figure 2.2).



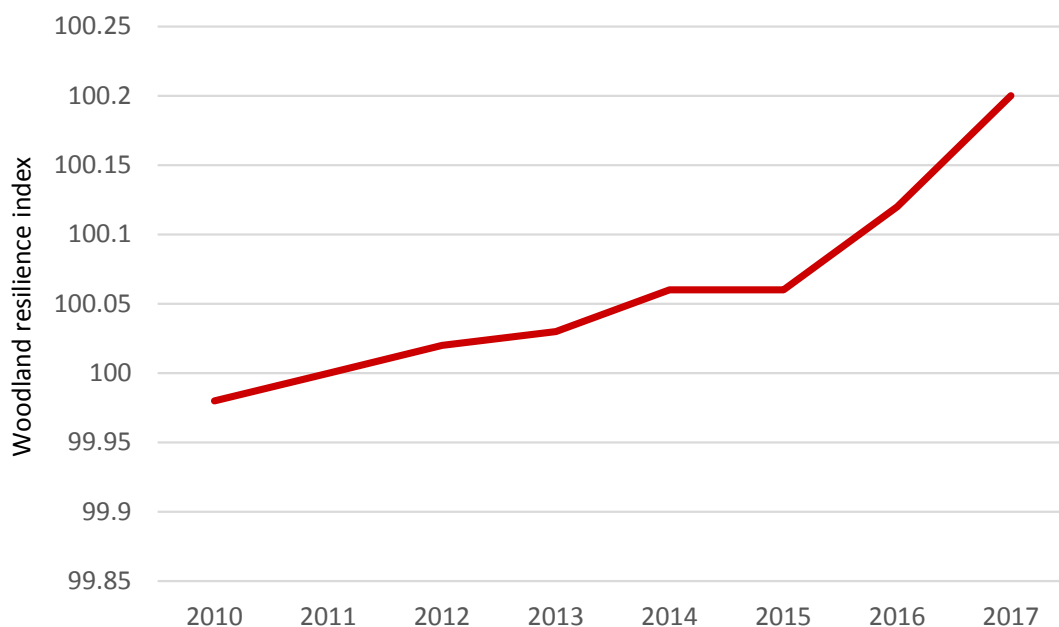
The complex interactions within ecosystems, future pressures such as pests and diseases, and land use changes, make it inherently difficult to predict the responses of woodlands to climate change. It is, therefore, difficult to know whether a woodland species, habitat or system is resilient to climate change. While it is likely that maintaining and improving connectivity will be important in supporting adaptations in a fragmented landscape under a changing climate, it is very challenging to measure at the national scale. The Forestry Commission has made some progress in this area, through its woodland resilience indicator (figure 2.3).

⁶⁶ CCC (2018) *Land use: reducing emissions and preparing for climate change*.

The indicator uses connectivity as a measure of the size and distribution of patches of forests and woodlands, relative to a value of 100 assigned to 2011. The indicator would benefit from the introduction of a resilience target, as without one it is not possible to determine whether progress is at a scale of improvement the Forestry Commission aims to achieve.

The indicator shows an increase in connectivity for forests and woodlands in England between 2010 and 2017. Over the same period there has been a corresponding increase in the area of forests and woodlands. The change in connectivity may be related to the overall increase in the woodland resource, the location in which new woodlands have been planted (i.e. in relation to existing woodland), or both. Much of the new planting that has occurred has been funded through agri-environment schemes, such as Countryside Stewardship, which encourages applicants to consider connectivity in their plans.

Figure 2.3. Measure of woodland resilience to climate change



Source: Forestry Commission administrative data and National Forest Inventory modelled by Forest Research.

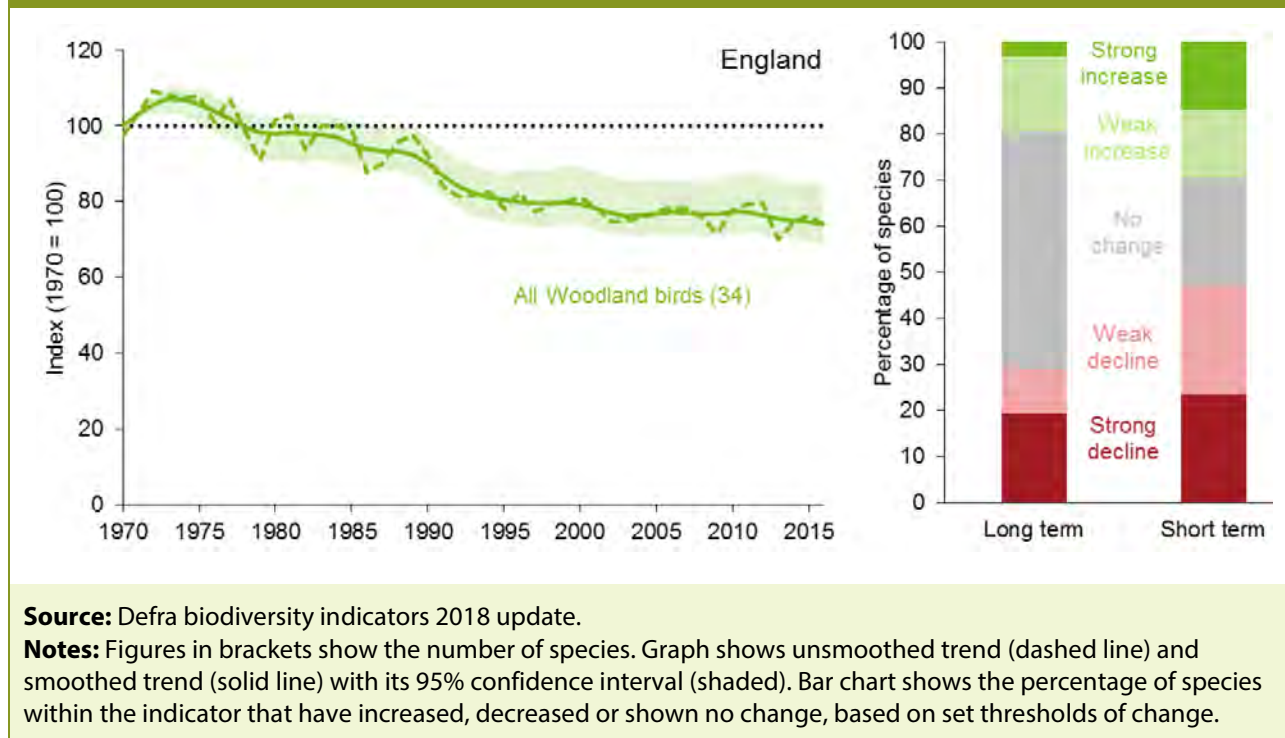
Notes: Indicator based on the size and spatial configuration of woodland patches within the landscape.

Birds and butterflies are regarded as good indicators of the general condition of wildlife and ecosystems as they are wide ranging with many habitat preferences. Birds also tend to be at the top of the food chain. Woodland provides habitat from canopy to ground level, important food resources for birds and butterflies, as well as nesting opportunities for birds and cover from predators.

The woodland bird index (see figure 2.4), produced as part of Defra's Biodiversity 2020 indicator set, shows combined changes in population of 34 woodland bird species. One definition of a resilient natural environment would be high biodiversity. An increase in the woodland bird index, therefore, can be interpreted as an increase in resilience. In 2016, the woodland bird indicator for England was 24% lower than in 1970, with the greatest decline occurring between the early 1980s and the early 1990s.

Since 1996, the index has been more stable. More recently the smoothed index showed no significant change between 2010 and 2015.

Figure 2.4. Breeding woodland bird species index



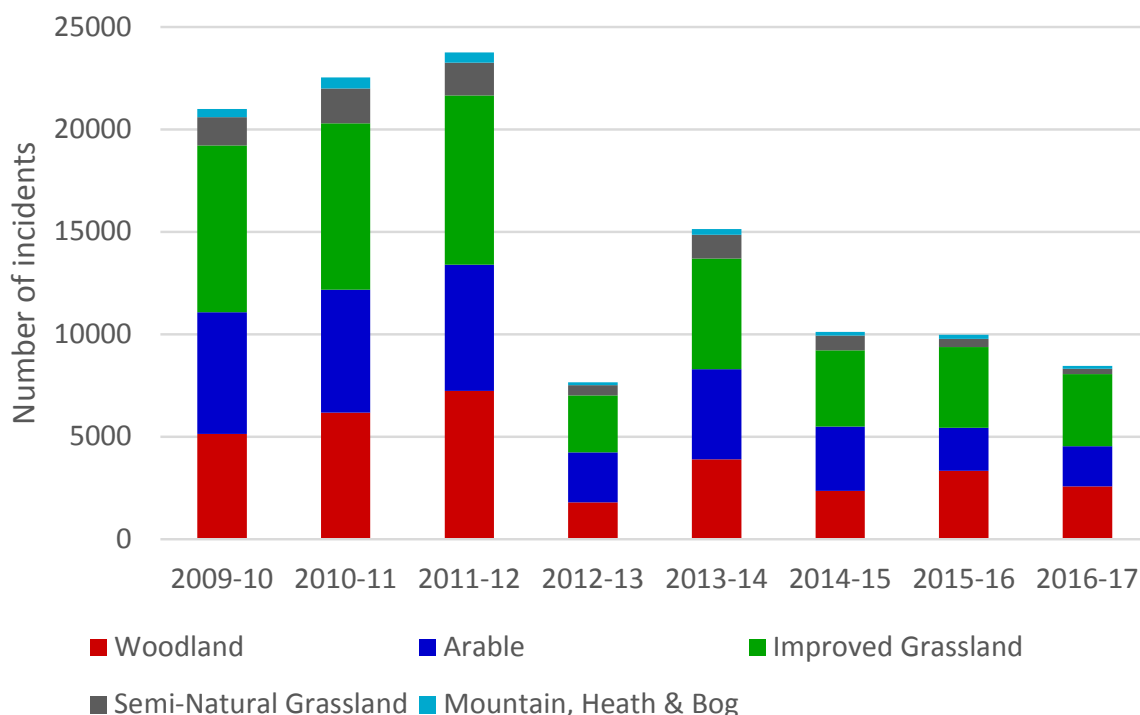
Defra also publishes a woodland butterfly index as part of the biodiversity 2020 indicator set. Since its base year in 1990, the index has fallen significantly (down 58%), although it has shown some recovery in recent years. The long-term decline is thought to be due to a lack of woodland management and loss of open spaces in woods.⁶⁷

CCRA2 stated that projections of drier springs and summers with increased soil moisture deficits would suggest an increase in the frequency and areas susceptible to wildfires in the UK. The south of England was identified as particularly at risk from a shift in weather conditions that help generate natural material to fuel wildfires.

Forestry England produces statistics for wildfire incidents attended by the Fire and Rescue Service (FRS) in England for the eight financial years 2009 - 2010 to 2016 - 2017. Figure 2.5 shows that the majority of wildfire incidents that occurred in the time series were associated with improved grassland, arable land and woodland. The number of wildfire incidents have been notably lower in the last five years (2012 - 2013 to 2016 - 2017) than in the three years prior to this (2009 - 2010 to 2011 - 2012). This coincides with drier conditions experienced during the 2009 - 2010 to 2011 - 2012 period (see also section 2.8).

⁶⁷ Defra (2018) *A strategy for England's wildlife and ecosystem services, Biodiversity Indicators: 2018 assessment*.

Figure 2.5. Total number of wildfire incidents recorded each year by the Fire and Rescue Services, split by land cover class.



Source: ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*.

Notes: Excludes fire incidents classified as occurring in built-up areas and gardens.

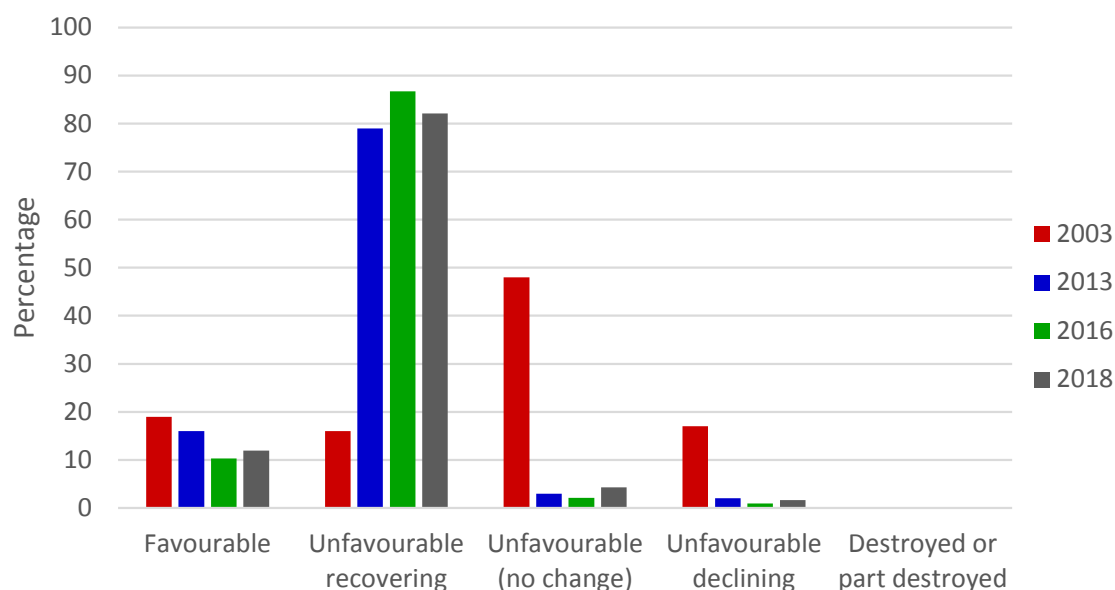
Restoration of peatlands, alongside woodland planting, was identified as a priority climate action measure in the CCC's land use report. The condition of these sites is an important indication of their ability to sustain their peat-forming and other functions in the face of climate change.

Upland peatlands cover 355,000 hectares in England⁶⁸, of which, 181,584⁶⁹ hectares (51%) are designated as SSSIs (as at 2018). Since 2003 there has been a marked shift in the condition of upland blanket bog SSSI sites from 'unfavourable' to 'unfavourable recovering' (figure 2.6). The percentage in unfavourable recovering condition was largely unchanged between 2013 and 2018. However, there has been a decline in the proportion in favourable condition, from 19% in 2003 to 12% in 2018.

⁶⁸ RSPB (2015) *England's upland peatlands – turning around a crisis*.

⁶⁹ <https://designatedsites.naturalengland.org.uk/NEInterimReports/ConditionByHabitat.aspx>

Figure 2.6. Upland blanket bog SSSIs in England, by condition



Source: For 2016 and 2018 data see Natural England:

<https://designatedsites.naturalengland.org.uk/NEInterimReports/ConditionByHabitat.aspx>

For 2003 and 2013 data, see ECI (2013) for the CCC, *Assessing preparedness of England's natural resources for a changing climate*.

The absence of routine national monitoring of soil condition in England means that it is currently difficult to determine whether progress is being made in managing vulnerability to climate change. The last national assessment of soil condition in England was published in 2007, as part of the Countryside Survey. The National Soil Inventory also reports on the condition of soils across England, but this has not been conducted since 2003. A reduced rolling annual Countryside Survey is due to commence in 2019. Over the next few years, the aim will be to revisit all the grid squares surveyed in 2007, but with a reduced set of measurements, focusing on plant monitoring and soil sampling for basic soil chemistry. Furthermore, as mentioned above, while actions outlined in the NAP to develop metrics to better monitor the condition of soils in England are ongoing, most have not progressed beyond the research stage.

Conclusion

Plans are in place that contain targets, which if met, would make significant steps in halting and reversing decades of degradation and fragmentation of the natural environment in England. However, current targets only relate to protected areas and not all priority terrestrial habitats. Furthermore, the plans lack a specific set of actions to meet the targets for terrestrial habitats and do not consider the long-term implications of climate change, including a substantial threat of lock-in to irreversible change. There is evidence of actions being taken to restore species, habitats and ecosystems, but most are in the early stages of development.

Despite these efforts, key indicators of environmental quality continue to decline. Only around one third of terrestrial SSSIs are in favourable condition. The percentage of blanket bog sites in favourable condition has dropped further from 19% in 2003 to 12% in 2018. Climate change is already adding to pressures on terrestrial habitats and species, and in the absence of further effort to build resilience, is likely to accelerate rates of decline.

2.3. Freshwater habitats and species

This adaptation priority covers semi-natural freshwater habitats as classified by Natural England; rivers, streams, standing open water and canals. The only indicators available that give any sense of vulnerability to climate change at present are based on the condition of freshwater sites of special scientific interest (SSSIs), and indicators taken from the Water Framework Directive on the ecological status of surface water bodies. These indicators are used as proxies to understand the state of and pressures on freshwater habitats in general, but do not distinguish which habitats in what areas are likely to be most vulnerable to climate change and what steps could be taken specifically to improve resilience. Better indicators could include: changes in abundance and distribution of climate sensitive freshwater species; and water temperature.

What is the risk?

Risks from reduced water availability, pollution and higher water temperatures will increase the degradation of freshwater habitats, and compromise the viability of some freshwater species.

CCRA2 identifies freshwater habitats as being particularly vulnerable to reduced water availability in the face of climate change. It notes that more action is needed to reduce pollution and improve the ecological condition of wetland habitats through encouraging the wider uptake of management practices that help to reduce the impacts of low and high flows. With regard to risks to freshwater species from higher water temperatures, CCRA2 also noted more research is needed to further refine the strategic approach to riparian tree planting to provide cooling for sensitive water bodies with high biodiversity. There are strong financial as well as environmental reasons for prioritising the restoration of water bodies.

CCC progress score	Reason for progress score
5	Plan score - medium: Plans are currently in place through the implementation of the Water Framework Directive (WFD) in England that consider the long-term risks to freshwater habitats from climate change. The Environment Agency is considering what adaptation is needed in 2°C and 4°C degree global temperature scenarios as part of its revisions to the River Basin Management Plans (RBMPs), to be published in 2021. The Plans outline required actions to bring freshwater habitats to good environmental status by 2021, or where this is not possible, by 2027. However, there are significant gaps. A clear mechanism that accounts for the consequences of higher water temperature and drying up of water bodies in meeting the WFD targets is still needed. There is also future uncertainty on the fate of RBMPs post-EU exit. Risk score - medium: There is a mixed picture of progress in improving the condition of freshwater habitats. The percentage of designated freshwater sites in favourable condition is improving, but the ecological condition of all surface water bodies assessed as part of the WFD continues to worsen.

Is there a good quality plan?

Are plans covered in NAP2?

Plans are in place to improve the condition of water bodies and to consider how to account for future pressures from climate change.

Most of the current policies and programmes outlined in NAP2 to support the resilience of freshwater habitats to climate change are contained within the 25-year Plan. The Plan includes a commitment to restore 75% of freshwater protected areas by 2043, but the pledge is vague in terms of what restoration means, and lacks a quantified set of actions to support it.

The Environment Agency (EA) is in the process of reviewing and updating the third cycle of RBMPs commencing in 2021. Climate change adaptation is an integral part of the RBMPs. As part of this, the EA has a programme of work to ensure that climate change projections of temperature, precipitation and sea level rise are incorporated into the RBMP revisions process. This involves national level risk assessments that consider environmental impacts from 2°C and 4°C degree global temperature scenarios out to 2050, and where possible draws on the UKCP18 projections. The EA has calculated that restoring 75% of water bodies to good status by 2027 would create net benefits for England of £5 billion.⁷⁰ The value of the benefits reflects improvements in water quality, air quality and recreation.

The obligation to review and update the RBMPs in England is set out in UK law, principally through the Water Environment Regulations 2017.

⁷⁰ Environment Agency (2015) *Impact assessment for the updated river basin management plans (2015): evidence base*.

While this ensures the review and update to the plans in 2021 under the current set of Water Framework Directive (WFD) Regulations, it is not clear yet how the Government plans to maintain the objectives and mechanisms set out in the WFD for protecting water bodies in the longer-term after the UK leaves the EU.

Are there other plans not mentioned in NAP2?

Restoration objectives under the EU Water Framework Directive (WFD) provide a legislative driver to achieve the 25-year Plan's goals for freshwater habitats.

The WFD requires that all defined water bodies meet 'good status' by 2021, or where this is not possible by 2027, through the implementation of RBMPs. NAP2 does not directly reference the WFD in relation to the Government's objectives for freshwater. The WFD is also the primary policy for managing the risk of higher water temperatures. Risks from increasing water temperatures, combined with changes to flow, will make meeting the WFD targets even more challenging.⁷¹ At present, however, there is no clear mechanism in place that accounts for the consequences of changes in water temperature for meeting the WFD targets.

The National Environment Programme (NEP) is a water company investment programme of monitoring and improvement measures to deliver water quality, water resources, and biodiversity outcomes.

The current NEP covers the period 2015 to 2021 and includes specific schemes to achieve good status and protected area objectives through improvements to the quality of the water environment.

For water quality, the NEP includes schemes to improve both continuous discharges, for example, from sewage treatment works, and intermittent discharges such as combined sewer overflows (see section 3.2.3). These schemes aim to improve protected areas, through reducing the risk of eutrophication, improving the quality of water that is discharged from sewage treatment works and improving inland waters for wildlife.

The NEP also includes measures to reduce the impact of water abstraction on the environment, balancing water companies' requirements to maintain public water supply and protect freshwater habitats. Part of this is to ensure water company abstraction is sustainable and does not impact on the aims of the WFD. It is not clear how the programme considers the potential impacts of future climate change on freshwater habitats.

Do the plans address the risks in CCRA2?

Plans as currently set out would go some way to addressing the risk, but EU-exit has created uncertainties over implementation, and plans are not in place that consider adaptation to higher water temperatures in meeting WFD targets.

The 25-year Plan's goal for freshwater habitats, if bolstered by restoration objectives under the WFD, would help in addressing risks to the ecological condition of freshwater habitats outlined in CCRA2. As yet, however, there is no clear mechanism in place that accounts for the consequences of higher water temperature for meeting the WFD targets.

⁷¹ CCC (2016) *UK Climate Change Risk Assessment 2017 Synthesis report: priorities for the next five years*.

Is progress being made in managing risk?

Are relevant actions taking place?

Actions are underway to improve the condition of water bodies, although there is still a gap in actions to address risks from higher water temperatures.

The Water Environment Grant (WEG) scheme is a grant funding scheme for improving the water environment in England, starting in 2018/19. It is administered by the EA and Natural England. The scheme has a £9 million per annum budget until March 2021. It is supported by funding from the European Agricultural Fund for Rural Development (EAFRD) and is part of the Rural Development Programme for England (RDPE). The WEG scheme has supported the delivery of projects with rural benefits which aim to:

- improve protected areas;
- achieve water body objectives, as set out in RBMPs; and
- prevent deterioration of water bodies, and protected areas.

The scheme cannot be used to fund projects that are already receiving EU funding. There is some uncertainty about the continuation of the scheme once the UK leaves the EU.

The EA is also implementing the Government's Water Abstraction Plan (see box 2.1). The plan aims to reduce pressures on the freshwater environment, through directing water more efficiently to where it is most needed, and reducing the amount of abstraction that can take place in vulnerable catchments (see section 2.6). Since 2008 the EA has changed 282 licences returning 40 billion litres of water to the environment. In addition, since 2017, the EA has reduced the risk of deterioration by revoking more than 600 abstraction licences.

The current 2015 RBMPs confirmed over £3 billion investment in the water environment during the six-year plan cycle period. Over 1,400 miles of surface water has been enhanced towards the EA's target of around 5000 miles by 2021.

NAP2 does not include any actions in relation to addressing risks to the ecological condition of surface water bodies from higher water temperatures.

Is there evidence that risk is being managed?

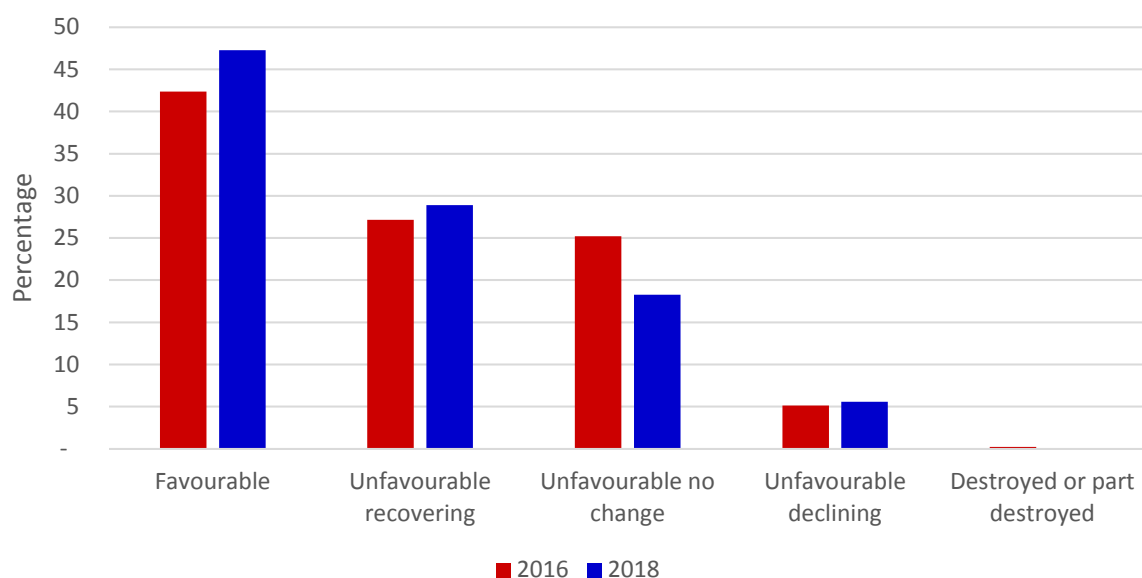
There is a mixed picture of progress in improving the condition of freshwater habitats. The percentage of designated freshwater sites in favourable condition is improving, but the ecological condition of all surface water bodies assessed as part of the WFD continues to worsen.

The latest indicators from Natural England of the condition of freshwater sites of specific scientific interest (SSSIs)⁷² show an increase in the number of sites in favourable condition, from 42% in 2016 to 47% in 2018 (figure 2.7). There has been a corresponding decline in freshwater habitats classed as unfavourable, down to 18% in 2018 from 25% in 2016. Freshwater SSSIs represent around 8%⁷³ of the total area of freshwater habitats in England.

⁷² Also referred to as 'designated sites'.

⁷³ 8% calculated by comparing area of designated rivers and streams, and standing open waters and canals according to Natural England designated sites data, with data on total area of freshwater habitats published in the ONS Land Cover Account as at 2007.

Figure 2.7. Freshwater SSSIs in England, by condition



Source: Natural England,

<https://designatedsites.naturalengland.org.uk/NEInterimReports/ConditionByHabitat.aspx>

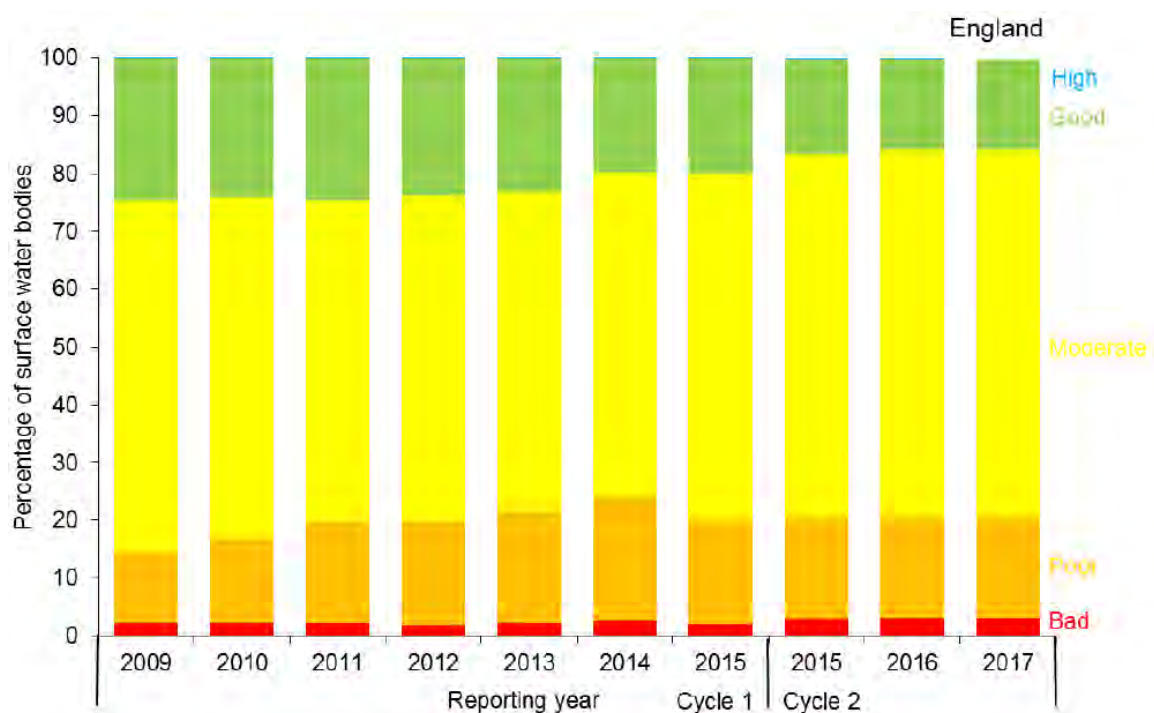
Notes: Designated sites represent around 8% of freshwater habitats in England.

Under the WFD, the EA also measures the ecological status of all surface water bodies in England (not just designated sites).⁷⁴ In 2017, only 16% of surface water bodies assessed under the WFD were in high or good ecological status, down from 24% in 2012 (figure 2.8). From 2021 the EA will reclassify water bodies to show where environmental improvements have been made, where improvements are still required before 2027, and where impact on the ecology and resilience of rivers and other freshwater sites are not yet confirmed.⁷⁵

⁷⁴ The measure shows progress towards commitments to reduce environmental pressures and protect freshwater ecosystems. The EA has responsibility for monitoring and reporting on the status of water bodies and the reasons why good ecological status has not been achieved ('reasons for failure'). Ecological status classes are defined between five boundaries (high, good, moderate, poor and bad) and are used in assessing the status of rivers, lakes, estuaries and coastal waters.

⁷⁵ Defra (2019) *Abstraction reform report: Progress made in reforming the arrangements for managing water abstraction in England*.

Figure 2.8. Proportion of water bodies in England meeting good status



Source: Defra biodiversity indicators 2018 update.

Notes: The indicator shows the percentage of water bodies in each status class under the WFD. Approximately 5,000 water bodies are assessed in each year of the indicator; including rivers, canals, lakes, estuaries and coastal waters.

Conclusion

Adaptation plans for freshwater habitats are currently in place in England, mainly through the implementation of the RBMPs. The plans consider the impact of reduced water availability as a result of climate change, contain clear outcomes and align to the goals for freshwater habitats outlined in the 25-year Plan. The fate of RBMPs post-EU exit, however, is not clear. There also remains a need for a clear mechanism that accounts for risks associated with higher water temperatures, as identified in CCRA2, if WFD objectives for protecting water bodies are to be achieved. Indicators suggest that some progress is being made for designated freshwater sites, but the condition of all surface water bodies continues to worsen.

2.4. Marine and coastal habitats and species

This adaptation priority covers the marine zone around England, and coastal habitats.⁷⁶ The indicators we have available to measure progress in adaptation of the marine environment include the condition of coastal sites of specific scientific interest (SSSIs)⁷⁷, and the area (but not condition) of marine protected sites. Indicators showing inputs of hazardous materials into the marine environment are also used as a proxy indicator of wider pressures that would reduce resilience to climate change overall. Unlike for terrestrial and freshwater habitats, the underlying hazard metrics that will affect marine biodiversity are also more straightforward to identify and so we include changes in these; sea surface temperature, and pH levels. We would welcome indicators that help inform on the impacts of acidification, temperature and salinity on marine species.

What is the risk?

Changes to the marine ecosystem around the UK that have been attributed to climate change, include variations in acidity, dissolved oxygen content, sea temperature and ocean stratification.

A need to build understanding of potential impacts of climate change on marine biodiversity, especially from changes in acidity, dissolved oxygen content, temperature and ocean stratification, was outlined in CCRA2. This was reaffirmed in Recommendation 7 of our 2017 report, which advised that research to assess the extent to which adaptive actions could increase the resilience of marine habitats and species to risks from climate change should be undertaken over the course of the NAP2 period.

CCC progress score	Reason for progress score
5	Plan score - medium: The Marine and Coastal Access Act (2009) sets out requirements for Marine Plans to take into account the risks from climate change, but it is not clear to date what specific actions will be set out in these plans and if the long-term risks from climate change are being addressed. Marine protected areas are not being designated with climate change in mind. Risk score - medium: • The proportion of designated coastal habitats in favourable condition remains static at around 60%, which is a much higher proportion than for terrestrial or freshwater habitats. • The extent of marine protected sites continues to increase, though no data are available on condition. • Pressures from pollution are declining over time.

⁷⁶ JNCC defines coastal habitat types and characteristics as including: shingle, soft and hard cliffs, saltmarsh, dunes and machair.

⁷⁷ Also referred to as 'designated sites'.

Is there a good quality plan?

Plans are in place to conserve and improve marine and coastal habitats, which include requirements to consider how marine planning can take climate change into account. However, none include specific proposals to adapt to the key climate risks facing the marine environment.

Are plans covered in NAP2?

NAP2 outlines actions to prepare marine plans that include policies for climate adaptation.

The UK Marine Strategy currently provides the legal framework for the environmental management of UK seas. The strategy includes overall ambitions for the marine environment, the targets to be achieved and the method to achieve those targets. It derives from the EU Marine Strategy Framework Directive (MSFD), which requires all member states to put in place measures to achieve good environmental status (GES) in their marine waters by 2020.⁷⁸

Regional marine plans are referenced within NAP2 as the current mechanism to increase and improve the management of seas around England. In line with commitments made in the 25-year Plan, NAP2 sets out that the Marine Management Organisation (MMO) has a responsibility to prepare 10 marine plans, covering the whole of the English marine area, by 2021⁷⁹. The Marine and Coastal Access Act (2009) initiated the production of Marine Plans, which, in accordance with guidance set out in the UK Marine Strategy, should: take into account the risks to marine habitats identified in the CCRA; relevant national adaptation programmes; and the latest set of UK Climate Projections. There are currently six published marine plans on the MMO website. Proposals outlined in existing plans indicate UKCP18 projections should be used when assessing how marine areas may be impacted by climate change. But the plans lack detail on the type of risk assessed, the level of temperature rise and timeframe covered, and do not include clear actions.

The Act also established Marine Conservation Zones (MCZs) as areas designated to protect nationally important, rare or threatened habitats and species. Plans to continue to establish MCZs are outlined within NAP2. To date, there have been 50 MCZs designated in waters around England, protecting an area of 7,886 square miles⁸⁰ and representing around 8% of England's offshore marine area.⁸¹ The formal public consultation on 41 new MCZs ended in July 2018, and over 48,500 consultation responses were received. All 41 new sites were designated in May 2019, safeguarding 12,000km² of marine habitat.⁸² This phase aims to complete the 'UK Blue Belt' and the UK's contribution to the ecologically coherent network in the North East Atlantic.

⁷⁸ GES is defined as "The environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive".

⁷⁹ Defra (2018) *The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting*.

⁸⁰ <https://www.gov.uk/government/collections/marine-conservation-zone-designations-in-england>

⁸¹ England's marine area in this instance is defined as the area of territorial sea and economic exclusion zone which totals 253,000 km² according to the UNESCO Marine Spatial Planning programme.

⁸² NAP action update – appendix A.

Many features for which the MCZs have been designated are potentially vulnerable to climate change, meaning their ongoing utility as a conservation tool could be affected.⁸³ For example, some features used for designations include the environment type (e.g. marine or estuarine), ecological significance (e.g. a specific habitat or species type) and environmental factors which influence species composition and community structure such as depth, substrate (e.g. mud, sand) and exposure (wave action, currents).

The UK's departure from the EU creates considerable uncertainty. Without the legal enforcement of the EU through the MSFD there is a danger that the UK will not deliver its current environmental protection and sustainable use objectives for the marine environment.

Are there other plans not mentioned in NAP2?

Outside of NAP2, no overarching plan currently exists for improving the resilience of marine and coastal habitats and species to the potential impacts from climate change.

Do the plans address the risks?

Existing marine plans lack detail on the actions that will be implemented in order to address risks identified in CCRA2.

Adaptation plans outlined in NAP2 provide some support in addressing the risks to marine and coastal habitats, and species outlined in CCRA2. However, those published to date lack detail on the specific actions that will be taken to adapt to rising sea temperatures and changing ocean chemistry in the long-term.

Is progress being made in managing risk?

Are relevant actions taking place?

NAP2 includes an action to conduct an assessment of progress of UK seas in achieving good ecological status (GES).

A consultation on Defra proposals for the assessment closed in June 2019.⁸⁴ The consultation covers the assessment of progress made towards achieving the targets set for GES in the Marine Strategy part 1 in 2012.⁸⁵ These relate to biological diversity, non-native species, commercially exploited fish and shellfish, food webs, human-induced eutrophication, sea floor integrity, hydrographical conditions, contaminants, contaminants in fish and other seafood, marine litter and introduction of energy (including underwater noise).

It also sets out proposals for updated high-level objectives, targets and operational targets to be used for 2018 to 2024. These build on those set in 2012 and take account of the assessment findings and developments toward achieving coordinated targets, indicators and thresholds nationally, in the European Union and in the OSPAR Convention for the Protection of the North East Atlantic.

⁸³ Watkiss, P., Cimato, F., Hunt, A. and Moxey, A. for the CCC (2019). *The Impacts of Climate Change on Meeting Government Outcomes in England*.

⁸⁴ Defra (2019) *Marine Strategy Part One: UK Updated Assessment and Good Environmental Status*.

⁸⁵ The Marine Strategy Part One outlined an initial assessment of UK seas and characteristics, targets and indicators of GES.

NAP2 also makes reference to research by the Marine Climate Change Impacts Partnership (MCCIP), which has published a series of report cards on how to manage protected marine species and habitats to help them adapt to climate change (see section 2.9 and below).

Seven report cards were published in 2018, each with a focus on a specific habitat or species, selected because they are known to be vulnerable to climate change impacts. The information gathered should support effective indicators of climate change and climate change impacts in the marine environment. MCCIP has commissioned further research topics including: 'climate of the marine environment', and 'impacts on biodiversity', as part of its 10 years of MCCIP report card, with further updates due to be provided throughout 2019.

Some progress has also been made by UK research groups, and others, in developing and deploying autonomous sensors for pH and other ocean acidification parameters. NAP2 outlines the setting up of the European hub of the Global Ocean Acidification Observing Network (GOA-ON), funded by Defra.⁸⁶

Is there evidence that risk is being managed?

The MCCIP report cards identify how exposure to hazards is changing in key marine habitats including seagrass, coral gardens, salt marshes and saline lagoons. Increasing sea surface temperatures in particular may have profound, but uncertain, effects on marine plankton, which underpin the marine food chain.

The report cards show that:

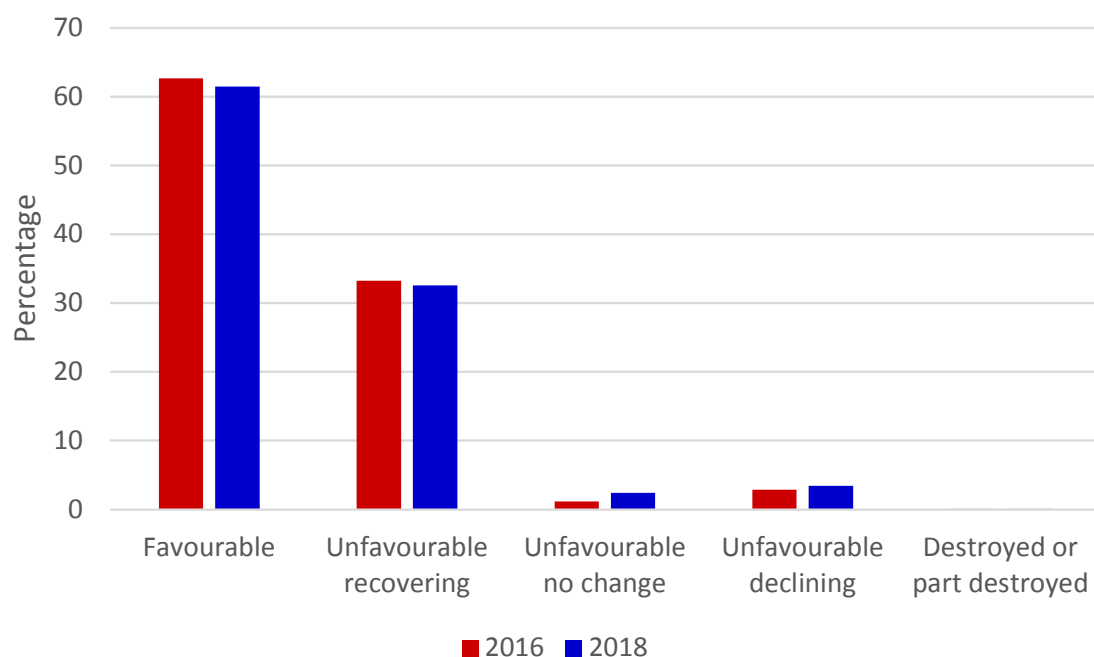
- Sea-surface temperatures (SST) in UK coastal waters and in the North-east Atlantic have risen by between 0.1°C and 0.5°C per decade since the 1980s. Between 2008 and 2013, sea surface temperatures in most areas around the UK levelled off or were slightly lower than observed between 2003 and 2007, but temperatures in 2014 were again relatively high. The observed temperature changes have been due to a combination of global climate forcing and natural variability in the ocean–atmosphere system. The implications for sea surface temperature on plankton abundance are highly likely to be negative, as colder water holds more oxygen and supports greater biomass. The extent of the risk, however, is still uncertain.
- The decrease in observed pH in the North Sea (over 30 years) and at coastal UK sites (over 6 years) seem more rapid than in the North Atlantic as a whole; pH measurements in the North Sea show a decrease of 0.105 units over the past 30 years. Under the goals of the Paris Agreement, limiting climate change to the RCP 2.6 scenario would equal a change in ocean pH of no more than 0.2 units.

As figure 2.9 shows, the proportion of coastal sites of specific scientific interest (SSSIs)⁸⁷ in favourable condition recorded a slight fall of around 1% between 2016 and 2018, but remains relatively high at 61.4% compared to terrestrial and freshwater habitats (see section 2.2 and section 2.3).

⁸⁶ NAP action update – appendix A.

⁸⁷ Also referred to as 'designated sites'.

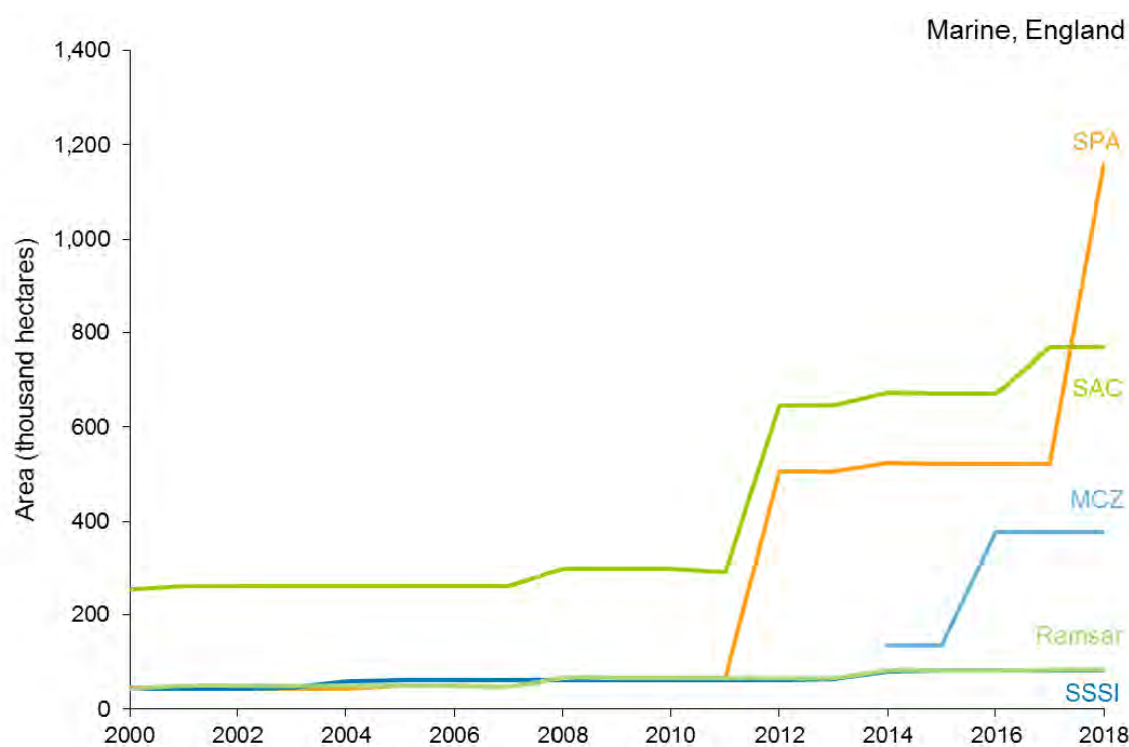
Figure 2.9. Coastal SSSIs in England, by condition



Source: Natural England,
<https://designatedsites.naturalengland.org.uk/NEInterimReports/ConditionByHabitat.aspx>

The area of marine protected sites has continued to increase substantially, by almost 69% to 1.7 million hectares in the five years to 2018 (figure 2.10). A large contributor to this has been the designation of inshore marine sites under the EU's Birds and Habitats Directives (see section 2.2).

Figure 2.10. Extent of marine protected areas



Source: Defra biodiversity indicators 2018 update.

Notes: Marine sites between mean low water and the 12 nautical mile limit are included; sites beyond 12 nautical miles, in UK waters, are excluded. These are included in the UK indicator on protected sites.

It should be noted that indicators such as that shown in Figure 2.10 only provide a sense of direction of travel, with more area protected deemed to enhance the ability of marine habitats to manage vulnerability though reducing pressures. Furthermore, data on the extent or condition of non-protected sites, some 92% of the total area, is not currently available.⁸⁸

Pollution is a further significant pressure on the marine environment, though problems with contaminants tend to remain relatively local to the sources and have been historically concentrated on industrialised coastlines and estuaries. Long term trends of the combined inputs of six hazardous materials into the marine environment have shown a long-term decrease of 80% since 1990 (figure 2.11). Marine litter such as plastics also represents a significant risk to the health of marine habitats and species. Indicators that track the extent and impact of plastic pollution in the marine environment around England are not currently available.

⁸⁸ Comprises all sites excluding protected areas.

Figure 2.11. Input of hazardous substances to the marine environment



Source: Defra biodiversity indicators 2018 update.

Notes: This indicator provides the combined input of six of the most hazardous substances to the UK marine environment: five heavy metals (cadmium, mercury, copper, lead and zinc) and one organic compound (lindane).

Conclusion

Despite the Marine and Coastal Access Act (2009) including requirements for Marine Plans to take into account the risks from climate change, the current set of plans do not include specific details as to the actions that will be taken and if the long-term risks, such as rising sea temperatures and changing ocean chemistry, will be addressed. The proportion of designated coastal habitats in favourable condition remains unchanged at around 60%. The extent of marine protected sites continues to increase, though no data are available on condition.

2.5. Farmland habitats and species

This adaptation priority considers habitats in the farmed countryside and the unique biodiversity – including internationally recognised populations of farmland birds, bats and butterflies - that they support.

The farmed countryside is a sub-category of the terrestrial habitats covered in section 2.2. Species capable of adapting to the changing agricultural landscape may be limited directly by the disturbance regimes of grazing, planting and harvesting, and indirectly by the decline in plant and insect foods available. Some management techniques, such as drainage, create such fundamental habitat changes that there are significant shifts in species composition compared to undrained sites.

The effects of agricultural activities in broader terrestrial habitats, such as intercropping, rotation, grazing and extensive usage of pesticides and fertilizers, and changes to the landscape on wild species of flora and fauna, are not included in this discussion.

Very few indicator trend data are available to assess the condition of the farmed countryside and its effects beyond the indicators of farmland sites of specific scientific interest (SSSIs)⁸⁹, which cover only 1% of the total area of farmed countryside, leaving most areas unassessed. Some data on the abundance of key species assemblages (pollinators and farmland birds) are also available and shown here. Given that the farmed countryside makes up 70% of the UK land area, the Committee would welcome more careful consideration of all indicator categories in farmed landscapes. These include indicators for: changes in hedgerow length; average field size; and proportion of degraded land area.

What is the risk?

The farmed countryside is exposed to similar current and future pressures from climate change as those facing the broader terrestrial environment, including risks from changes in average temperatures, rainfall patterns and seasonality.

As mentioned above, farmland habitats are a sub-category of terrestrial habitats. As such, the farmed countryside is exposed similarly to the current and future pressures from climate change as those facing the broader terrestrial habitats and species (see section 2.2), but farmland areas are exposed to many other pressures from agricultural practices. Required actions to build resilience include improvements to the ecological condition of the farmed countryside, and restoration of degraded ecosystems, particularly farmed lowland peatlands. With regard to peatlands, CCRA2 emphasised the need for further action to improve the condition of degraded soils, better protect soils from damaging practices and encourage the wider uptake of soil conservation.

⁸⁹ Also referred to as 'designated sites'.

CCC progress score	Reason for progress score
1	Plan score - low: Proposals for an Environmental Land Management Scheme under the Government's Agriculture Bill could form a comprehensive plan to improve the resilience of biodiversity in the farmed countryside to climate change. However, more detail is needed on how climate change impacts will be incorporated into local natural capital plans and what adaptation actions will be rewarded, as there are no goals or targets for such action at present. Risk score - low: • Relevant actions are taking place, but they have not been sufficient to date to reverse the decline in key indicator species. • Abundance of pollinator species continues in a long-term downward trend, though in the short-term it has remained stable. Farmland bird species show a steep decline over the long term. • The percentage of farmland SSSIs in favourable condition remains relatively high at 60%, but this indicator has limited value as it only covers 1% of farmed countryside.

Is there a plan?

Are plans covered in NAP2?

The Government's proposed long-term agricultural strategy to replace current Common Agricultural Policy (CAP) measures does not (yet) represent a comprehensive and effective plan to reduce the vulnerability of biodiversity in the farmed countryside to climate change.

As outlined in NAP2, the Government is currently working to develop a new long-term agricultural strategy to replace the existing Common Agricultural Policy (CAP).⁹⁰ Under proposals outlined in the draft Agriculture Bill, a new environmental land management (ELM) scheme for farmers and land managers will be introduced based on payments for public goods (see section 2.7). Improvements in water and land management, reducing flood risk, protecting the health of plants and livestock, and adapting to climate change are included as a 'purpose that is potentially eligible for financial assistance'. However, the provisions do not specifically include protection and enhancement of biodiversity as a public good (or soil health, both of which are notable omissions, even if both may be enhanced through improving the environment as set out in the Bill). The success of the system will also be heavily dependent on whether enough funding is made available to incentivise properly the sorts of changes needed to improve natural assets.

⁹⁰ Defra (2018) *The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting*.

Current agri-environment schemes (AESs) under Pillar II of the CAP provide components of a plan to improve the resilience of the farmed countryside to climate change, but have no overarching targets or goals for adaptation. AESs are noted in NAP2 as presently the principal mechanism for improving the condition of farmland habitats both on and off the protected site network. There is evidence to suggest the range of activities incentivised through AESs are making some contribution to improving the resilience of the farmed countryside.⁹¹ However, the schemes fall short of a comprehensive and effective long-term plan to address the risks facing farmland habitats from climate change. The schemes lack clear goals and timeframes, and without measurable targets it is not possible to capture the contribution that AESs make to climate change adaptation.

Following the UK's decision to leave the EU, the Government has confirmed that, even with a 'no deal' EU exit, funding will be guaranteed for agri-environment scheme agreements signed by the end of 2020 for the life of the agreement.⁹² It has included a clause, however, that this is provided they offer 'good value for money' and are 'in line with domestic strategic priorities', which creates some uncertainty.

Are there other plans not mentioned in NAP2?

No overarching adaptation plans for adapting the farmed countryside are in place outside those covered in NAP2.

Do the plans address the risks in CCRA2?

Current AESs provide some components of an adaptation plan, but they are of insufficient quality to address the risks to the farmed countryside from climate change outlined in CCRA2.

For instance, while AESs do encourage soil conservation efforts, management practices continue that degrade ecosystems, particularly on lowland peatlands. The proposed ELM Scheme could form a comprehensive plan to improve the resilience of biodiversity in the farmed countryside to climate change, but more detail is needed.

Is progress being made in managing risk?

Are relevant actions taking place?

Relevant actions are taking place to protect soil health and water quality, primarily.

The Countryside Stewardship – Facilitation Fund, as covered in NAP2, supports groups of farmers and land managers to improve the natural environment by conducting actions that restore degraded ecosystems. As at February 2018, the fund was providing financial help to 98 groups covering over 450,000 hectares. This represent less than 1% of farmed land in England.⁹³ Defra has published a range of case studies to illustrate the approaches taken by the groups.

NAP2 includes an action to conduct research on the resilience of agri-environment schemes. Defra has published research assessing the effectiveness of Environmental Stewardship and Countryside Stewardship schemes in supporting climate change adaptation. The objectives of the project were to develop a framework for future agri-environment monitoring, and undertake

⁹¹ Natural England (2018) *Assessing the contribution of agri-environment schemes to climate change adaptation*, a report by Atkins Ltd for Government.

⁹² HM Treasury (2016) *Funding from EU programmes guaranteed until the end of 2020*.

⁹³ Based on total area of farmed land in England taken from ONS UK Natural Capital Land Cover in the UK. Total includes land classification areas: rain-fed herbaceous crops, permanent crops, pastures.

a detailed spatial analysis to develop a national baseline against which future change can be compared.

As part of the NAP2 priority to introduce the ELM scheme, work is underway with farmers, land managers, environmental experts and stakeholders to develop policy which will be underpinned by payment of public money for the provision of environmental public goods approach.⁹⁴

Defra is in the process of forming a Lowland Agricultural Peat Taskforce, which will deliver recommendations for a new, more sustainable future for agriculture on lowland peatlands in England.⁹⁵

NAP2 outlines a new set of rules for farmers and land managers to prevent pollution, protect water quality and improve soil health, which came into force in April 2018. The rules set out what farmers must do or consider to manage risks posed by manures, manufactured fertilisers and soils through runoff, erosion and leaching. The Environment Agency is responsible for enforcement.

The rules apply to farming or horticultural practices, such as:

- using and storing organic manure or manufactured fertiliser;
- planting and harvesting;
- soil management, for example, ploughing or planting cover crops; and
- managing livestock.

The rules apply to all farmers located in a Nitrate Vulnerable Zone⁹⁶ and in receipt of funding from the Basic Payment Scheme, Countryside Stewardship or Environment Stewardship.

Is there evidence that risk is being managed?

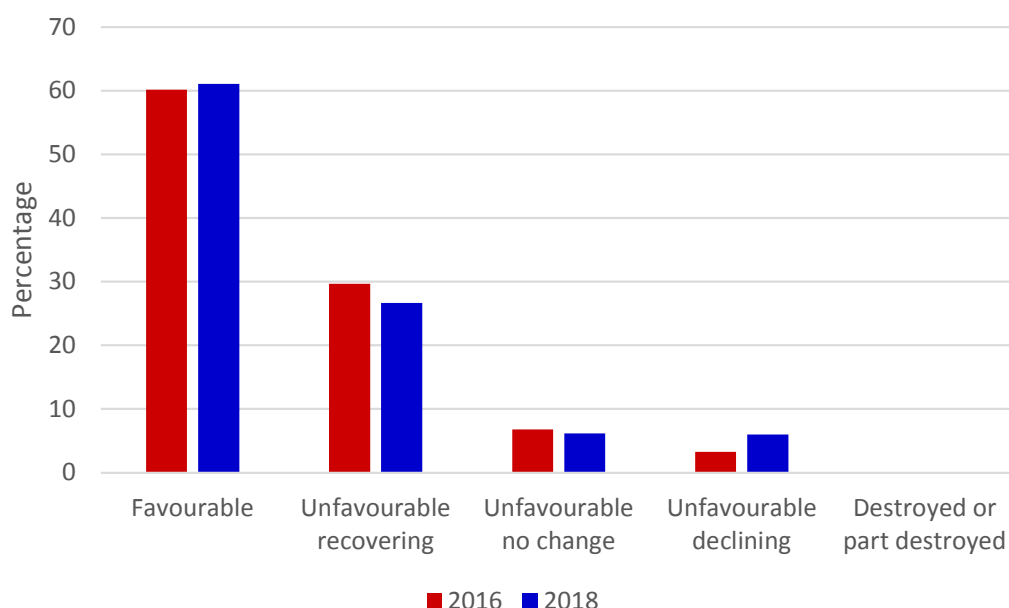
While the percentage of SSSIs in the farmed countryside that are in favourable or unfavourable recovering condition remains relatively high (88%), sites such as these represent less than 1% of the total area of farmed habitats (figure 2.12).

⁹⁴ NAP action update – appendix A.

⁹⁵ NAP action update – appendix A.

⁹⁶ Nitrate Vulnerable Zones (NVZs) are areas designated as being at risk from agricultural nitrate pollution. They include about 55% of land in England.

Figure 2.12. SSSIs in the farmed countryside, by condition

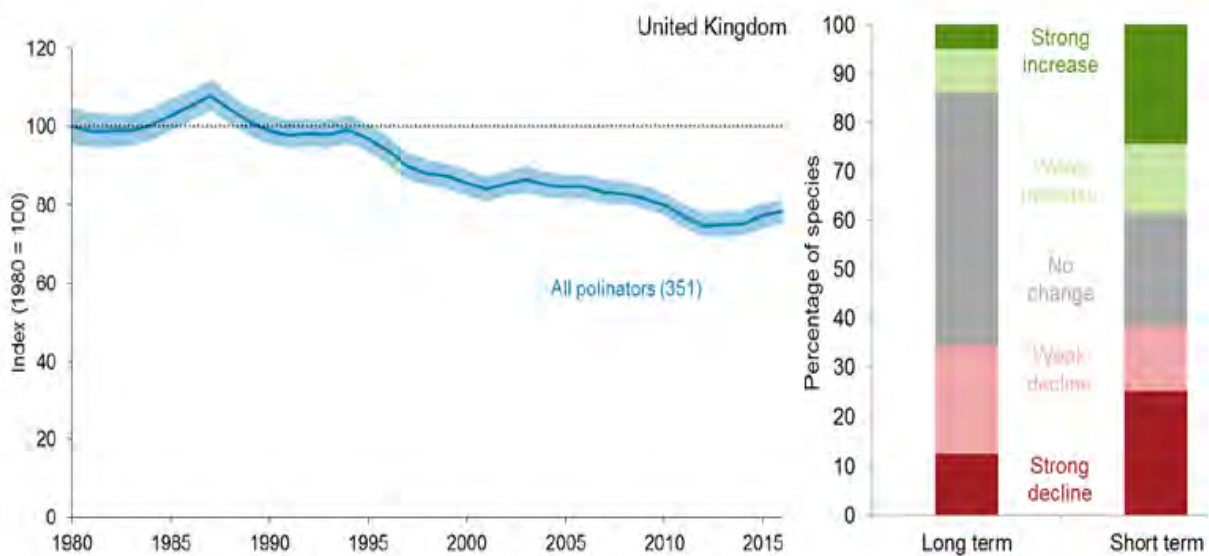


Source: Natural England,
<https://designatedsites.naturalengland.org.uk/NEInterimReports/ConditionByHabitat.aspx>

The downward trend in abundance indicators for key species in the farmed countryside suggest AESs have had limited impact on managing pressures on biodiversity to date.

The pollinator species occupancy indicator shows changes between 1980 and 2016, and is based on a total of 351 pollinators, comprising 137 wild bee species and 214 hoverfly species. There was an overall decrease in the pollinator indicator from 1987 onwards. In 2016, the indicator had declined by 22% compared to the value in 1980 (figure 2.13). Between 2011 and 2016 the indicator showed a minor increase of 2%, however given the uncertainty, the short-term trend was assessed as stable.

Figure 2.13. Pollinator species occupancy index

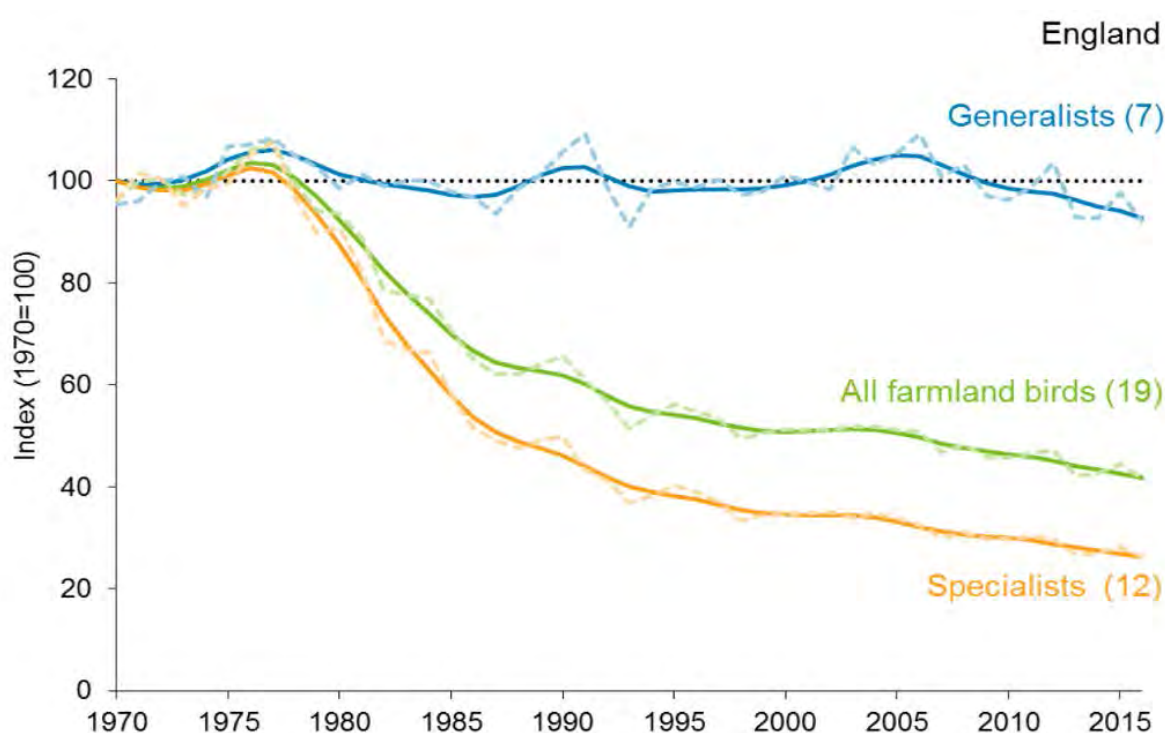


Source: Defra biodiversity indicators 2018 update.

Notes: This indicator illustrates changes in pollinator distribution (bees and hoverflies) in the UK. The indicator is based on 351 species of pollinator (137 species of bee and 214 species of hoverfly), and measures change in the number of 1km grid squares across the UK.

Farmland birds are used as an indicator of the general quality of the farmed environment because of their position near the top of the food chain. In 2016, the England farmland bird index was less than half its 1970 value having fallen by 57% (see figure 2.14). The long-term decline of farmland birds in England has been driven mainly by the decline of those species that are restricted to, or highly dependent on, farmland habitats (the 'specialists'). For example, between 1970 and 2016, the farmland specialists index declined by 73%, while farmland generalists declined by only 4%.

Figure 2.14. Farmland bird index – specialists and generalists



Source: Defra biodiversity indicators 2018 update.

Notes: The figures in brackets show the number of species in each index. The graph shows the unsmoothed trends (dashed lines) and the smoothed trends (solid lines).

Conclusion

The adaptation plans in place for the farmed countryside are not of sufficient quality to address the risks identified in CCRA2. The decline in abundance for key species in the farmed countryside suggest AESs have had limited impact on managing pressures on biodiversity to date. Initial details indicate the ELM Scheme could form a comprehensive plan to improve the resilience of biodiversity in the farmed countryside to climate change, but more detail is needed.

2.6. Water management

This adaptation priority considers the regulating services related to the availability and quality of water in the environment, and flood risk management provided by the natural environment. Freshwater biodiversity is covered in Section 2.3. Here the focus is on the human use of water and flood risk management. The indicators take into account how abstraction pressures are changing over time; efforts to enhance or retain water volumes, enhance or maintain water recharge from surface and ground water, and limit surface run-off. Additional indicators could include: uptake of nature based solutions for flood risk management; and soil condition for flood risk management.

What is the risk?

Water scarcity is identified in CCRA2 as an urgent risk to a large range of receptors: people, businesses, infrastructure; agriculture and wildlife. If additional action is not taken, the majority of catchments in England are projected to have insufficient water to meet demand by the 2050s.⁹⁷

To promote clean and plentiful water for people and the natural environment, more action is needed to prioritise water use where it is needed most, and ensure decisions on the use of water take account of long-term climate change. Reducing demand for water where possible so that abstraction pressure is kept to a minimum is also an important adaptation.⁹⁸

Flood risk, including to agricultural land, is also highlighted as an urgent risk in CCRA2. Land that is frequently flooded can only support the production of lower-value crops, pasture or woodland (see section 2.7), and the natural environment is also an important aspect of managing the risk from flooding, through natural flood management measures such as tree planting. Regular flooding imposes significant financial cost on land managers and land owners. Over 40,000 hectares of agricultural land were inundated during the 2007 floods in England, causing damages estimated at £50 million.⁹⁹

CCC progress score	Reason for progress score
5	Plan score - medium: In terms of water availability and quality, the Government's Water Abstraction Plan aims to promote flexibility in the abstraction system in England so that it is more responsive to future changes in water availability, though it is not clear as yet what specific actions will be taken to achieve this. The Environment Agency is conducting national scale risk assessments as part of the River Basin Management Plans to consider the impacts of climate change under 2°C and 4°C global temperature scenarios, which is encouraging. In terms of flooding, there are no goals set out in current policies for how land should be used to manage flood risk as the climate changes. Risk score - medium: • Abstraction of water for human uses has declined over the last ten years, which could suggest a decline in vulnerability to future water deficits, although on its own is a very limited indicator. • The use of land for natural flood management is poorly recorded.

⁹⁷ HR Wallingford et al. for the CCC (2015) *CCRA2: Updated Projections for Water Availability for the UK: Final Report for the Adaptation Sub-Committee*.

⁹⁸ CCC (2016) *UK Climate Change Risk Assessment 2017 Synthesis report: priorities for the next five years*.

⁹⁹ Environment Agency (2010) *The costs of the summer 2007 floods in England*.

Is there a good quality plan?

Are plans covered in NAP2?

The Government's water abstraction plan as outlined in NAP2 provides a framework to respond more flexibly to the impacts of climate change. NAP2 does not, however, include an adequate strategy for managing the risks of flooding in the natural environment, including agricultural land, or how the natural environment should be used to manage flood risk.

NAP2 references the Government's Water Abstraction Plan (WAP)¹⁰⁰ as the main tool in addressing risks from water scarcity, both now and into the future. The WAP provides a framework for the management of water taken from the natural environment. Its targets are aligned to the 'clean and plentiful water' goal in the Government's 25-year Plan. This includes targets to reduce damaging abstraction of water from rivers and groundwater to levels that ensure that surface water bodies and groundwater bodies have enough water to support Good Ecological Status (GES) under the EU Water Framework Directive (WFD) (see Box 2.1). The WFD targets are important as a mechanism to protect freshwater habitats (as mentioned in section 2.3) but also to maintain the resilience of water supplies to people in the future by better prioritising when and where water is abstracted for human use, whilst leaving sufficient water in the natural environment to support biodiversity. The WAP refers to the link between climate change and sustainably abstracted water bodies and the benefits of a stronger catchment focus in delivering greater sustainability and access to water. However, the Plan does not account for the 2°C and 4°C global temperature scenarios.

Box 2.1. Abstraction reform

The system for managing abstraction of water from rivers and aquifers was introduced in the 1960s. Most abstractors were given a licence to take a fixed volume of water, regardless of availability. This has resulted in three main problems:

- older licences allowing for abstraction that can damage the environment;
- an inflexible approach not able to cope with the pressures of increasing demand for water and climate change in the long term, or to allow abstractors access to additional water when it is available; and
- an outdated and paper-based service.

Government committed to reform the water abstraction management system in England in 2011. In December 2017 the abstraction plan was published. It has three main elements and aims to:

- make full use of existing regulatory powers and approaches to address unsustainable abstraction and move around 90% of surface water bodies and 77% of groundwater bodies to the required standards by 2021;

¹⁰⁰ Defra (2019) *Abstraction reform report: Progress made in reforming the arrangements for managing water abstraction in England*.

Box 2.1. Abstraction reform

- develop a stronger catchment focus – bringing together the Environment Agency, abstractors and catchment groups to develop local solutions to existing pressures and to prepare for the future. These local solutions will:
 - protect the environment by changing licences to better reflect water availability in catchments and reduce the impact of abstraction; and
 - improve access to water by introducing more flexible conditions that support water storage, water trading and efficient use.
- support these reforms by modernising the abstraction service, making sure all significant abstraction is regulated and bringing regulations in line with other environmental permitting regimes.

Defra laid a report before Parliament in May 2019 on the progress made in reforming the arrangements for managing water abstraction in England, meeting a requirement of the Water Act 2014. This report set out key milestones in abstraction reform up until December 2027, when the Environment Agency will have updated all abstraction licensing strategies.

Source: Defra (2019) *Abstraction reform report: Progress made in reforming the arrangements for managing water abstraction in England*.

The WFD targets are reiterated in the Government's 25-year Plan, under the clean and plentiful water goal. The River Basin Management Plans (RBMPs) include a programme of measures to meet these objectives. As part of the work to update the RBMPs which is currently underway, the EA is conducting national scale risk assessments in the draft RBMP considering the impacts of climate change under 2°C and 4°C global temperature scenarios (see section 2.3). Findings from the assessments will be taken into account when determining the objectives for the next RBMP cycle, commencing in 2021.

As also outlined in NAP2, Defra is currently consulting on regulatory reforms to the water sector in England. The Government has made improving the water sector's ability to respond more flexibly in the face of extreme weather conditions and other effects of climate change a key objective of the reforms. It is not clear from the consultation, however, what actions the Government will be taking in order to achieve this. The Government aims to report to Parliament in 2019 on progress made on abstraction reform. This will include updates on these actions and the actions set out in its WAP.

The Flood and Coastal Erosion Risk Management (FCERM) strategy lacks sufficient detail on how the natural environment should be used to address flood risk.

Managing flood risk in relation to agriculture, forestry and the natural environment is integrated into the FCERM Strategy for England. However, the Strategy does not outline goals for establishing what an acceptable level of risk of flooding of agricultural land is, and lacks details on how the natural environment should be best used to manage flood risk.

Are there other plans not mentioned in NAP2?

Opportunities exist for using agricultural land, forestry and natural features to manage flood risk.

New defences and improvements to existing defences are undertaken to protect agricultural land as part of the wider programme of flood risk management in England (see Chapter 3). Water level management plans are also prepared by the Environment Agency (EA), Internal Drainage Boards, and some local authorities, depending on who exercises drainage powers in each part of the country.

As well as risks from flooding to agricultural land, opportunities exist for using agricultural land, forestry and natural features to manage flood risk. The Agriculture and Environment Bills represent an ideal route to capitalise on this, but at present there are no goals or actions setting out how these could be achieved. Consideration is also missing as to the balance needed between using the natural environment as a flood mitigation measure, and reducing the risk of damaging flooding to agricultural land. Indeed, the current draft of the Agriculture Bill only lists reducing flood risk by incentivising good soil management (see section 2.7), in turn leading to a reduction in soil compaction, as a public good for which financial assistance may be eligible. Further consideration is needed if the recommendations outlined in the Environment, Food and Rural Affairs Committee's 2017 report on future flood prevention¹⁰¹, to put flood risk management at the centre of new support schemes for farmers, are to be addressed.

Do the plans address the risks in CCRA2?

Revisions to the RBMPs which consider the potential impacts under 2°C and 4°C global temperature scenarios are a significant step in ensuring adaptation decisions on the use of water address the future risk to agriculture and wildlife from water scarcity identified in CCRA2. Consideration of long-term climate change also needs to be fed through the whole programme of work on abstraction reform.

Clear goals and associated actions are needed for both managing the risks from flooding to the natural environment (including agricultural land) and how the natural environment can best be used to mitigate flood risk elsewhere, taking into account long-term climate change.

Is progress being made in managing vulnerability?

Are relevant actions taking place?

Actions are taking place to improve strategic planning for increased water scarcity in vulnerable locations.¹⁰² Actions to improve management of flood risk focus largely on providing support and tools for land managers.

The WAP states that by 2021, the EA should remove unused licences and reduce those that are underused, as well as bring previously exempt abstractors under regulation. Defra has reviewed and re-issued guidance to farmers on managing their water assets, to ensure that guidance is in line with abstraction reform.

The EA is working with abstractors and existing local groups in catchments potentially facing the greatest water scarcity challenges in the future. Work has started in four catchments and will

¹⁰¹ Environment, Food and Rural Affairs Committee (2016) *Future flood prevention - Second Report of Session 2016–17*.

¹⁰² Vulnerable in this context relates to locations where water resources are already scarce and the environment under pressure from abstraction.

look at collaborative approaches to regulation using the catchment-based approach. This includes investigating how access to water can be improved for abstractors, whilst improving sustainability of abstraction.

As part of the RBMPs revisions process, the EA has an ongoing programme of climate resilience work that aims to build climate change risk into assessments for waterbodies. This includes a 'challenges and choices' consultation involving collaboration with stakeholders to investigate the key challenges affecting the water environment and work with partners to discuss best choices to addressing them.

Defra provided £15 million in funding in 2017 to implement over 50 natural flood management schemes in England.¹⁰³ Thirty-four community led projects received funding to take forward innovative plans to use landscape features such as ponds, banks, meanders, channels, and trees to store, drain or slow flood water. Twenty-four other catchment scale projects were also allocated funding to develop larger scale projects, which will benefit wider areas.

In 2017, the EA published an analysis of interventions based on an assessment of some 65 case studies on natural flood management (NFM). The analysis provides flood risk managers with a resource to access up-to-date information on implementing measures that help to protect, restore and emulate the natural functions of catchments and floodplains.

Work to update Shoreline Management Plans (SMPs) is underway (see also chapter 3). Guidance will be produced as part of the process that will incorporate the latest evidence on sea level rise from UKCP18, as well as the latest mechanisms to inform management approaches. It is not clear at this stage when the process will complete.

Is there evidence that risk is being managed?

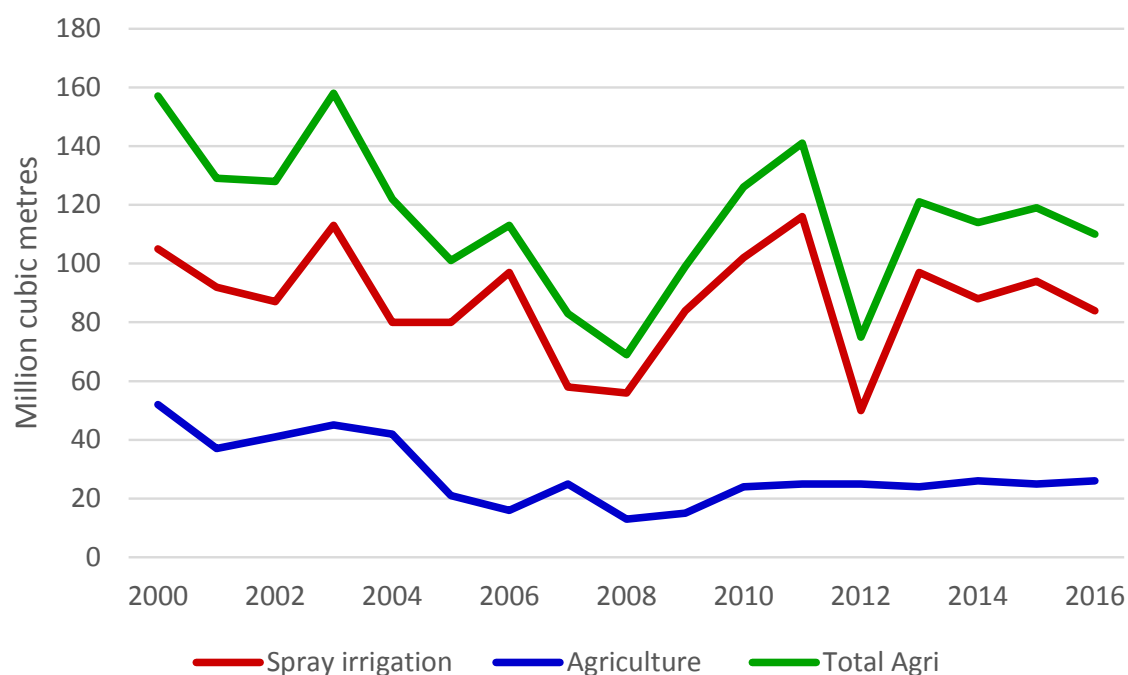
There have been declines in the volume of water abstracted for agriculture and spray irrigation since 2000, although the proportion of farms using on-farm water storage facilities has remained low.

There has been a 30% decline in abstraction of non-tidal water for agriculture over the 2000 to 2016 period (figure 2.15) with the main drop happening between 2000 and 2008.

The reasons for this decline in abstraction are unknown. Further work is needed to understand the trend and whether it is linked to actions to reduce abstraction pressure mentioned above.

¹⁰³ Defra (2017) *Schemes across the country to receive £15 million of natural flood management funding*.

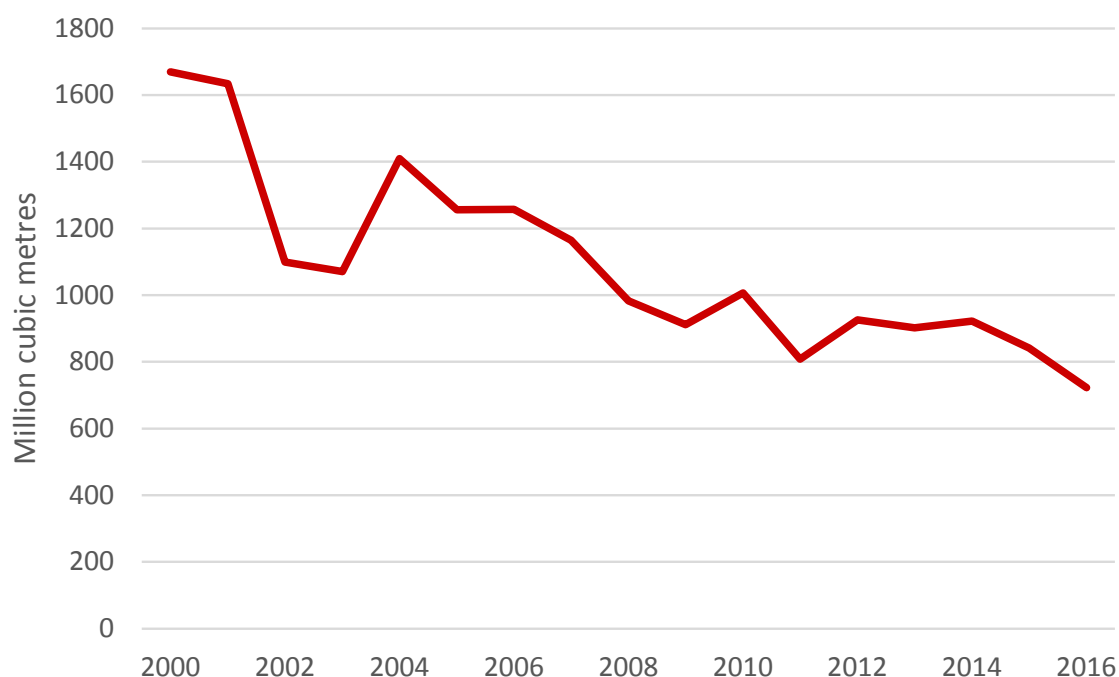
Figure 2.15. Volume of abstractions from non-tidal water sources for agriculture in England



Source: Environment Agency.

Fish farming remains a significant water user compared to agricultural food production, although there is a downward trend in the absolute volume of water abstracted. Abstractions fell by 57% between 2000 and 2016, from 1,700 million cubic metres to around 700 million cubic metres (figure 2.16). The share of water abstracted for fish farming compared to total abstractions from non-tidal sources has also halved over the reference period, declining from 15% in 2000 to just over 7% in 2016.

Figure 2.16. Volume of non-tidal water abstracted for fish farming in England



Source: Environment Agency.

Notes: Includes fish farming, cress growing and amenity ponds.

Developing on-farm water storage capacity can be an effective adaptation measure to minimise the negative impacts of drought. Data derived from the Farm Business Survey show that the percentage of farm businesses using different water sources has remained relatively similar over the 2013 - 2014 to 2015 - 2016 period (table 2.2).¹⁰⁴ There has been a slight increase in the percentage of farms using rivers, streams and springs for abstraction for immediate use from 2013 - 2014 to 2015 - 2016. The percentage of farms using rainwater storage and ponds, lakes and reservoirs remained low across the three years of available data.

¹⁰⁴ <https://www.gov.uk/government/collections/farm-business-survey>

Table 2.2. Percentage of farm businesses sourcing water from various water sources

Water source	Percentage of farm businesses		
	2013-14	2014-15	2015-16
Mains water	86	86	85
Rivers, streams, springs for abstraction (immediate use)	28	29	31
Boreholes	24	25	25
Rainwater storage	7	7	8
Rivers, streams, spring for abstraction (storage)	5	4	5
Ponds/lakes/reservoirs	3	2	2

Source: ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*.

Notes: The highest volume of irrigation water applied per annum, by source, in cubic metres (excluding unexplained outliers and watercress production). Where respondents grew crops in more than one production sector, their applied water quantity is counted in each of those production sectors. There were 503 responses to this question, from growers of potatoes, field horticulture, protected horticulture, and outdoor containerised plants.

The use of land management as a tool for natural flood management is poorly recorded. It is crucial to understand whether appropriate actions are being taken and the standard of additional flood risk protection they are providing if adaptation is to be effectively assessed.

Conclusion

Plans are in place and actions are being implemented to address increased risks of water scarcity in vulnerable locations. The WAP contains clear targets, but it does not directly account for long-term 2°C and 4°C global temperature scenarios. England still lacks an effective strategy for using the natural environment to manage flood risk. NAP actions for this aspect of the priority focus on research and providing support and tools for land managers. It is too early to tell what effect these measures will have on the long-term risks of water scarcity.

2.7. Agricultural productivity under climate change

The agricultural productivity adaptation priority considers how climate change could affect the ability of the land to support domestic food production in the future as the climate changes. The priority considers the degree of innovation and flexibility in agriculture, the resilience of crops and livestock to climate change impacts including pests and diseases, and the resilience of the underpinning assets as they are needed to support agriculture – soil and water. If climate change degrades land capability overall, agricultural production will not be able to take advantage of any potential benefits from longer growing seasons. There are very few indicators to assess vulnerability for this priority – we have no metrics for soil health for example. Water quality and quantity is covered in terms of indicators in the ‘water management’ priority. We have some proxy indicators of technological capability of the sector, but not specifically in relation to resilience against pests and diseases that are likely to increase as the climate changes. Better indicators could include evidence about the resilience of crop (including crop sub-strains) and livestock varieties to drought, heat, pests and diseases, and actions underway to adapt domestic agricultural practices accordingly.

What is the risk?

Water restrictions will have potential consequences for agricultural businesses, particularly those specialising in crops that are dependent on supplementary irrigation.

Projected warmer, drier summers and increased mean winter temperatures, however, may be beneficial for some crops. CCRA2 also notes a likely increase in risk to agriculture from pests, pathogens and invasive non-native species. One notable risk highlighted in both CCRA1 and CCRA2 is livestock production being affected by greater incursion of exotic diseases, such as bluetongue. As covered in section 2.6, at the other extreme, increased flood risk may reduce land capability to support agriculture in vulnerable locations (notably in river and coastal floodplains).

Recommended actions in CCRA2 included an assessment of the suitability of current agricultural systems in the future given the projected changes in droughtiness and aridity, and a continuation of measures to implement surveillance and bio-security systems.

CCC progress score	Reason for progress score
1	Plan score - low: There is no coherent strategy to ensure that agriculture remains productive as the climate changes, through protection of crops and livestock, and management of pests and diseases, or takes advantage of potential opportunities through soil and water resilience. There are partial plans in place for protecting against the ongoing loss of lowland peat soils, although most are still in development. The Environmental Land Management Scheme (ELMS) has the potential to help the agriculture sector adapt to climate change, but there is no detail (as yet) on what will be required in terms of adaptation Risk score - low: There are actions taking place such as investment in technology to improve the efficiency of the agri-food sector, and research to improve the management of lowland agricultural peat soils. There are no robust indicators that provide a basis on which to assess progress, including for soil health or R&D investment.

Is there a good quality plan?

There remains no coherent strategy, either inside or outside of NAP2, to ensure that current and future agricultural production in England is adapting to the changing climate.

Are plans covered in NAP2?

Although market forces will play a large role in driving what farmers produce in the future (including changing productivity due to climate change), there are some aspects of maintaining agricultural capability that have long lead times and a risk of lock-in. Proactive adaptation planning will be required, particularly with regard to water and soil management, and improving the technological capability of the sector to respond to threats such as changing pest and disease risks.

The management of these risks requires a long-term strategy; this is still missing in NAP2. As set out above, the Environmental Land Management (ELM) scheme outlined within the Government's Agriculture Bill and referenced in NAP2¹⁰⁵, includes climate change adaptation in the defined list of public goods, however, this is limited largely to building resilience with regard to flood risk management. Furthermore, there is no detail (as yet) on what will be required in terms of adaptation, what is being aimed for, and how that will be measured. The ELM scheme rollout is provisionally planned from 2025 - 2027 and a plan is also still needed in the interim.

Agricultural soils are being degraded by intensive farming practices in some areas (such as the Fens), with deep ploughing, short rotation periods and exposed ground leading to soil erosion from wind and heavy rain. NAP2 draws on the aspiration included in the Agriculture Bill to manage land so as to improve soil quality. However, it is unclear at this stage what is meant by soil quality, how it will be measured or how changes in land use as a result of changing incentives would be taken into account. It is the subject of some debate as to whether soil can be considered a public good and as such should attract public payments for soil conservation measures.

¹⁰⁵ Defra (2018) *The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting*.

Are there other plans not mentioned in NAP2?

The Agri-tech Strategy provides a partial plan for improving the tech-capability of the sector through collaboration and data sharing.¹⁰⁶

The Agri-tech Strategy aims to provide support to farmers to invest in new technology, to reduce costs or improve product quality. The four Agri-Tech Centres that have been established through the Strategy are targeting the development and deployment of agricultural technologies in the UK.¹⁰⁷ These should help to improve the farming sector's ability to adapt to climate change through, for example, helping to inform farmers on ways to diversify the genetic composition of crops grown, and improve control measures for pests and diseases. The Government has published results of a scoping study, which developed a baseline against which to measure the performance of the agri-tech sector, and provided recommendations on a suite of metrics to support monitoring and evaluation of the Strategy. However, leaving landscape scale adaptation to local land managers and farmers, without the support of an effective national strategy, is unlikely to be sufficient to manage the risks from climate change (see chapter 1).

NAP2 does not include any plans to address potential risks to agriculture from pests, pathogens and invasive non-native species.

At present, the Animal and Plant Health Agency (APHA) is responsible for monitoring and responding to pest and disease threats to agriculture.¹⁰⁸ APHA has embedded some climate change risks identified in the CCRA2 into their planning and surveillance arrangements. For instance, APHA is supported by The Pirbright Institute, an independent reference laboratory, providing research and surveillance of diseases of farm animals. The institute provides diagnostic and surveillance capability for ten viral exotic diseases (including Bluetongue).

The Government's current definition of invasive non-native species does not include species that arrive in the UK if their migration is deemed as a result of climate change. This means that invasive non-native species identified as a risk within CCRA2, such as *Culicoides*, a genus of biting midges and vector species for the Bluetongue disease, would not be included in policies that cover invasive species if they become more established in the UK as a result of climate change. This omission seems arbitrary as the factors that influence the existence and spread of invasive species cannot be easily disentangled; the more important factor is the likely degree of damage to the environment, health and the economy that may arise once they arrive and become established.

Do the plans address the risks in CCRA2?

Current adaptation plans for the agriculture sector are not sufficient to address the risks from climate change identified within CCRA2.

Adaptation plans for the Agriculture sector contained within NAP2 do not represent a coherent strategy to address the full range of risks identified within CCRA2, including impacts from drought, soil loss and risks to agricultural productivity from greater incursion of exotic pests and diseases. The proposed ELM scheme does include climate change adaptation with regard to building resilience to flood risk.

¹⁰⁶ Defra (2015) *Agricultural technologies (agri-tech) strategy*.

¹⁰⁷ <https://www.agritechcentres.com/>

¹⁰⁸ CCC (2016) *UK Climate Change Risk Assessment 2017 Synthesis report: priorities for the next five years*.

However, the current scope is too narrow and does not include the resilience of livestock to climate change impacts including pests and disease, and the resilience of the underpinning assets (e.g. soil, water) as they are needed to support agriculture. Outside of NAP2, some plans are in place for improving the sector's ability to cope with increased risks to production from pests, pathogens and invasive non-native species.

Is progress being made in managing risk?

Are relevant actions taking place?

Actions are taking place to improve the management of agricultural soils, although work in this area is at a very early stage of development.

The Countryside Productivity Scheme provides funding for projects which improve productivity in the farming and forestry sectors in England. Under the scheme, grants are available for improving farm productivity, adding value to agri-food, water resource management and reservoirs. The first round of funding for grants was launched in February 2018 with around £15 million issued to farmers who applied to buy new kit. The second round of Government funding closed for applications in March 2019, with over £30 million made available for farmers.

In 2018, the Government allocated £90 million to bring together artificial intelligence, robotics and earth observation to improve supply chain resilience in the agri-food sector. The funding will target the creation of 'Translation Hubs', which aim to bring together farmers and growers, scientists and Centres for Agricultural Innovation to apply the latest research to farming practice.

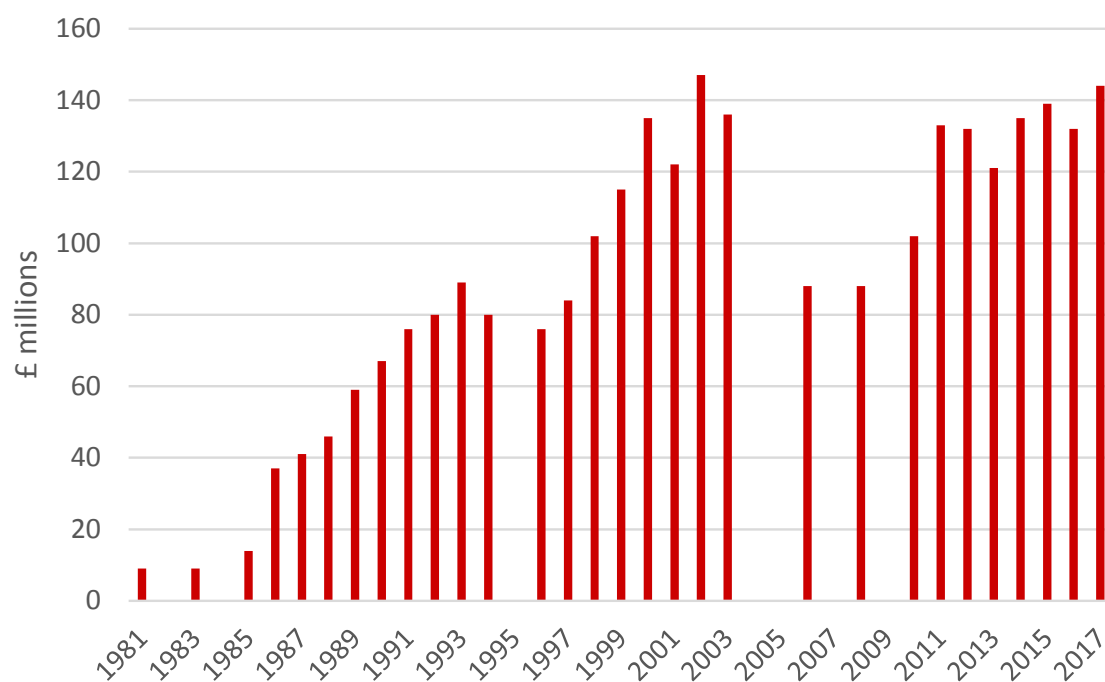
Our 2017 progress report included a recommendation for proposals to reverse the ongoing loss of lowland peat soils in order to provide mitigation and adaptation benefits. As mentioned in section 2.5, Defra is in the process of forming a Lowland Agricultural Peat Taskforce, which will deliver recommendations aiming for a new, more sustainable future for agriculture on lowland peatlands in England. Its objective is to reduce the ongoing loss of lowland peat soils, with a focus on greenhouse gas emission reductions. It is expected that the Taskforce will commence in the autumn of 2019. However, there are no specific plans for assessing or improving soil quality on any other agricultural soils in England at present.

Is there evidence that risk is being managed?

Indicators to measure how the capability of the agricultural sector is changing in relation to climate change are very limited.

The amount of investment in agricultural research and development (R&D) on climate-specific issues would be a useful indicator of action. Data on R&D investment for agriculture, forestry, fisheries and hunting is available from the Office for National Statistics (figure 2.17). At present, sub-industry supporting data for this indicator are not available, meaning we are unable to assess changes in the agriculture portion of R&D investment.

Figure 2.17 UK R&D funding (£m) for agricultural research



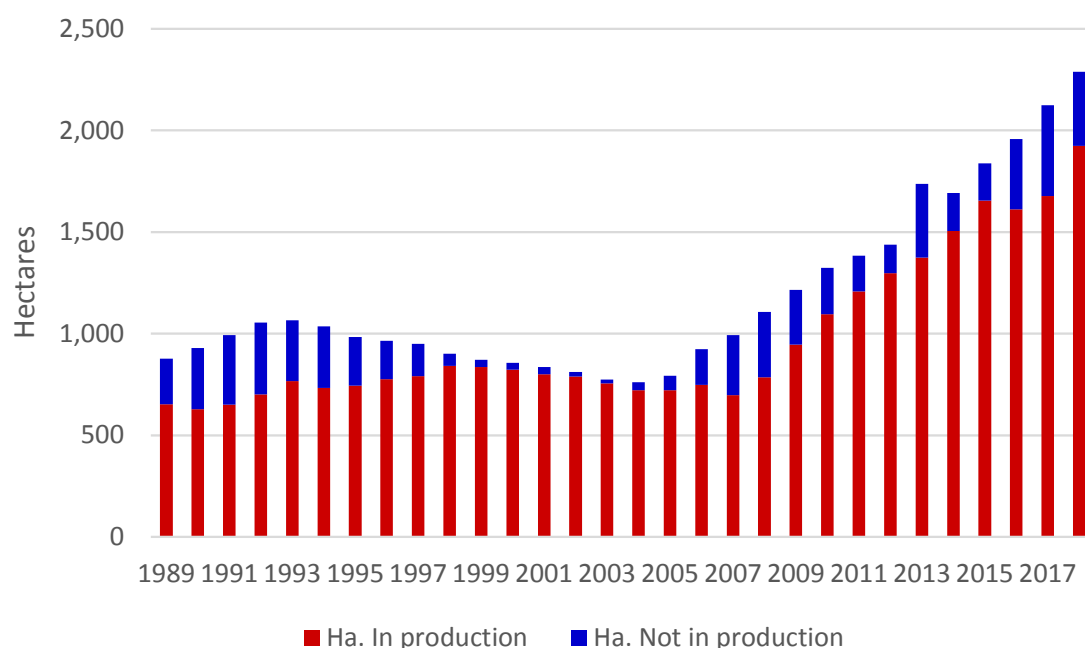
Source: Office for National Statistics.

Notes: Includes total intramural research and development spending by the agriculture, forestry, fishing and hunting sector. Data is in current prices. No data available for the years: 1982, 1984, 1995, 2004, 2005, 2007, 2009.

Climate change in the UK may have some beneficial effects for the agriculture sector due to more favourable conditions emerging relative to other parts of the world. Evidence of changing production to date in response to climate change is difficult to find, but one example is the wine industry in England and Wales. The impact of climate change on wine production in England is generally reported to be positive, because of the shift to a more favourable (warmer) climate for wine growing.¹⁰⁹ The total area planted with vines in England and Wales has trebled since 2004 from 761 hectares, to an estimated 2,289 hectares in 2018 (figure 2.18).

¹⁰⁹ Watkiss, P., Cimato, F., Hunt, A. and Moxey, A. for the CCC (2019). *The Impacts of Climate Change on Meeting Government Outcomes in England*.

Figure 2.18. Wine Production - Area planted (ha) per year in England



Source: ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*.

Notes: Does not include 'hobby vineyards' or 'abandoned vineyards'.

Conclusion

There is currently no overarching plan that considers the range of risks to and opportunities for the agricultural sector in England from climate change. While the ELM makes some consideration of climate change adaptation, the scope is limited largely to flood risk management, and does not address the broader suite of risks to agricultural productivity identified in CCRA2. Outside of NAP2, some plans are in place for improving the sector's ability to cope with increased risks to production from pests, pathogens and invasive non-native species, however, increased Government support is needed if they are to be effective. Furthermore, without effective indicators to monitor changes in the capability of agriculture in relation to climate change, it is hard to assess how the sector is managing current and future risk.

2.7 Commercial forestry

This adaptation priority considers adaptation to manage England's woodlands as a timber resource.

This section considers managing forests to reduce vulnerability to future change by planting species that are likely to be climatically suitable over the long-term, diversification to reduce the risk from pests and diseases, and other forms of active management to reduce the risks from drought, fire and wind. Indicators are available showing the degree of diversification of species planted by Forestry England, and process indicators for active management (although it is not clear what form this management is taking). More specific metrics, linked to specific climate risks, would help. Examples of these include: tree sapling losses as a result of extreme weather; geographical spread of different climate-sensitive pests and pathogens.

What is the risk?

Forestry faces significant risks from pests, pathogens and invasive species; and extreme climate events (wind, drought, heat, fire) now and increasingly in the future.

Risks from pests, pathogens and invasive species are identified in CCRA2 as substantial problems for forestry both now and in the future, affecting ground and understorey flora, competing for water and nutrient resources and inhibiting natural tree regeneration. Existing invasive species such as rhododendron that compete with trees may increase their range in a number of areas, and new invasive non-native species, pests and pathogens are likely to arrive in the country as the climate warms.¹¹⁰

Other risks identified as potentially major problems for forestry across the UK include wind damage; warmer autumns, with consequent later leaf loss are likely to increase the risk of damage in deciduous species as foliated trees are more at risk from wind. In addition, increased tree mortality from drought and from pests and diseases may in turn increase wildfire risk, through increased volume of fuel.

Recommended actions in the CCRA2 to address the identified risks to forestry included continued monitoring of and increased research into the impacts of extreme weather events on forestry production, and continuing to implement surveillance and bio-security measures.

¹¹⁰ CCC (2016) *UK Climate Change Risk Assessment 2017 Synthesis report: priorities for the next five years*.

CCC progress score	Reason for progress score
5	Plan score - medium: Forestry England's (FE) longstanding climate change action plan, which expired in 2017, will be re-released within FE in 2019, but not published online. Full details of the Plan are not available at this time. There are partner initiatives that consider near-term risks and benefits from climate change to the Nation's Forests, specifically pests and diseases, and ensuring that new planting takes future climatic suitability into account. Risk score - medium: There is mixed progress in managing risk. Targets for tree planting are being missed. The Forestry Commission's target for increasing the area of forest under active management has been missed, however, the diversity of tree planting is still increasing.

Is there a good quality plan?

Plans are in place that take into account the current impacts to the forestry sector from climate change risks, and outline the actions required to address them.

Are plans covered in NAP2?

NAP2 includes a commitment to take forward the forestry sector's Climate Change Action Plan.

Forestry England (FE) will replace its 2011 Climate Change Action Plan for the Public Forest Estate¹¹¹ (CCAPFE) with a document aimed at an internal audience to support its species diversification programme. FE is developing a number of other adaptation and resilience measures alongside the CCAPFE, although details of this are not available at this stage. FE is also producing a Policy Approach on Forest Resilience for the Nation's Forests, which includes a high-level risk matrix and outline action plan, due for release later in 2019.

The Forestry Climate Change Working Group (FCCWG) is a cross-sector initiative consisting of public and private organisations and representing the 35 signatories to the 2015 Forestry Climate Change Accord.

It has published a separate Action Plan for Climate Change Adaptation of forests, woods and trees in England.¹¹² The Plan provides a single point of focus for collective action on climate change adaptation in the forestry sector. It is integrated into the activities associated with the Tree Health Resilience Strategy and is complementary to FE's Action Plan. The FCCWG's Plan contains 13 priorities for actions over the next five years – several of which are directly linked to reducing the risks outlined in CCRA2. It identifies lead organisations best placed to own specific actions and deliver them in collaboration with others as necessary, and provides a basis for monitoring progress with actions.

¹¹¹ The 'Public forest estate' is now referred to as 'the Nations Forests'.

¹¹² NAP action update – appendix A.

While the Plan contains a range of outcomes (24 in total) aligned, in varying degrees, to each of the priority actions, the outcomes lack specific targets and clear deadlines for achieving them.

The Forestry Commission's Woodland Creation Planning grant, is a key tool in supporting the Government's commitment to achieve annual woodland planting targets (see section 2.2) through well-designed woodlands.

A requirement of the grant is to consider future impacts of climate change on growth rates. The Forestry Commission will also publish a position statement on climate change later in 2019, covering its role in terms of research, policy and practice.

The UK Plant Health Risk Register (UKPHRR) is recognised within NAP2 as the mechanism by which the UK assesses plant and tree health risks in the UK.

The UKPHRR allows not only for the characterisation of risk but also prioritisation, via a scientifically based process to decide on the key actions to be taken to reduce risks, such as research and contingency planning. The UKPHRR is supported by collaborative horizon-scanning and information-sharing activities with international organisations, such as the European and Mediterranean Plant Protection Organisation. While this provides early warning of new pest threats, it is not clear how future climate change impacts are considered within the UKPHRR.

As outlined in section 2.2, NAP2 also includes partial plans that consider how woodlands need to adapt to a changing climate. The Government published the Tree Health Resilience Strategy for England in 2018.¹¹³ The focus of the Strategy is to improve the capacity of woodlands to adapt to climate change pressures through mitigating and minimising the impact of pests and diseases, as well as species and provenance choice. The Strategy advocates the adaptation goals set out in the Lawton Review (2010) as priority objectives to address the urgent risks to woodlands noted in the CCRA2.

Are there other plans not mentioned in NAP2?

Outside of NAP2, no published plan currently exists for improving the resilience of the forestry sector to climate change.

Do the plans address the risks?

Adaptation plans exist within the forestry sector that consider current risks from extreme weather, pests and diseases, and outline a range of supporting actions and desired outcomes. However, the current plans focus more on implementing near term actions, rather than long term aspirations, and do not give any explicit consideration of the future risks to forestry production outlined in the CCRA2.

Is progress being made in managing vulnerability?

Are relevant actions taking place?

Some actions are taking place to monitor current risks from invasive non-native species and to improve forestry production through research into tree species diversification.

Forestry Commission conducts annual monitoring of high-risk pests and diseases, via its ongoing annual surveillance programme. The programme is supported by both aerial and on-ground monitoring. Tree health risk analysis is integrated with the UKPHRR, which identifies 17 high-risk pests and diseases for forestry.

¹¹³ Defra (2018) *The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting*.

A new glasshouse facility, which aims to boost timber production through supporting species diversification on the Nation's Forests was opened at the Delamere nursery in 2018. The growing facility will test a range of environmental controls to create better growing conditions for the four million seedlings it houses and will examine which species do best in different conditions.

Delivering on its commitment within the 25-year Plan, the Government has appointed a new national Tree Champion. The main duties of the role include driving forward woodland planting rates and collaborating with Defra to strengthen the protection of trees from pest and disease threats and improve the resilience of trees in England.

In partnership with the University of Portsmouth and Forest Research, the Forestry Commission has published a briefing note on Next Steps for a Wildfire Danger Assessment in the UK.¹¹⁴ The document provides options and recommendations for the development of a Fire Danger Rating, System, including the development of fuel and risk maps.

Is there evidence that risk is being managed?

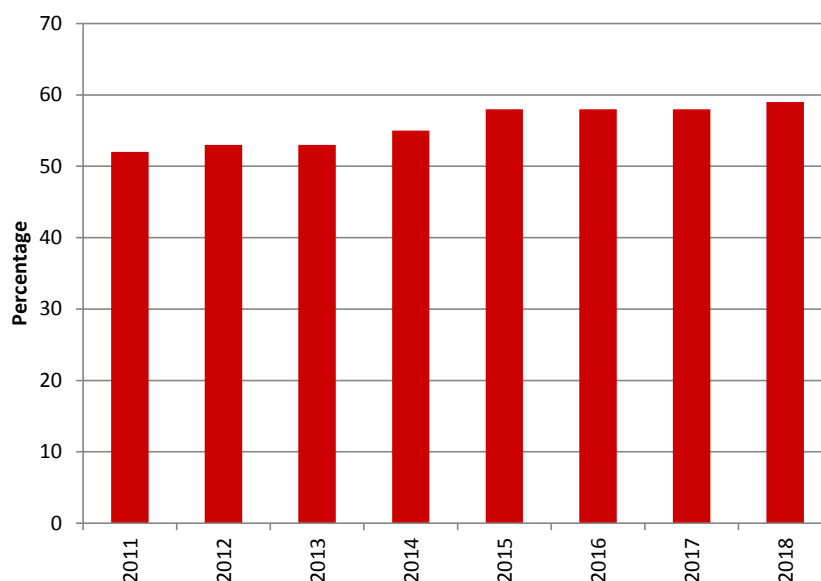
There has been an increase in the diversity of conifer and broadleaved species being planted. However, the proportion of woodland under active management has remained largely unchanged since 2015.

Active management is seen by the Forestry Commission as an essential pre-requisite to adapting commercial and other forests for climate change. This has been recognised in the 25-year Plan, which focuses on increasing the proportion of broadleaf woodlands that are sustainably managed. Intervening to increase resilience is characterised by increasing species and genetic diversity, planting or restocking with species better able to cope with future climatic conditions, converting to continuous cover systems of management and reducing other pressures such as over grazing by deer, and by controlling grey squirrel populations. Active adaptation measures, therefore, can only be introduced if woodlands are in management.

The percentage of woodland under active management has increased from 52% in 2011 to 59% in 2018 (figure 2.19). This is below the Forestry Commission's target to increase the percentage of woodland in active management to 66% by 2018. The bulk of the increase occurred between 2013 and 2015 (+5%). Since then the proportion under active management has seen a modest rise of 1%.

¹¹⁴ NAP action update – appendix A.

Figure 2.19. Percentage of woodland in England under active management, by area size (hectares)

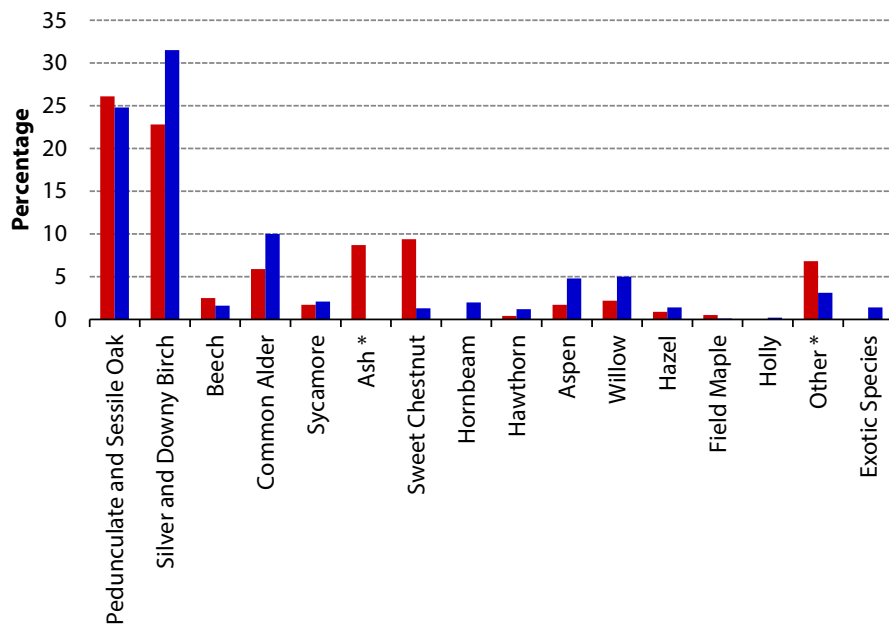


Source: Forestry England.

Notes: As of 2018, 59 out of every 100 hectares of English woodland are actively managed, totalling 764,000 hectares of woodland in management.

Increasing the diversity of tree species in new plantings is an important adaptation strategy designed to reduce threats from pests and diseases, and to help manage uncertainties around the suitability of particular species to future climate conditions. In 2017 - 2018, 22 different major species of broadleaf tree were planted by Forestry England in the Nation's forests. This is up from 17 in 2010 - 2011 (figure 2.20).

Figure 2.20. Percentage of broadleaf species planted on the Nation's Forests

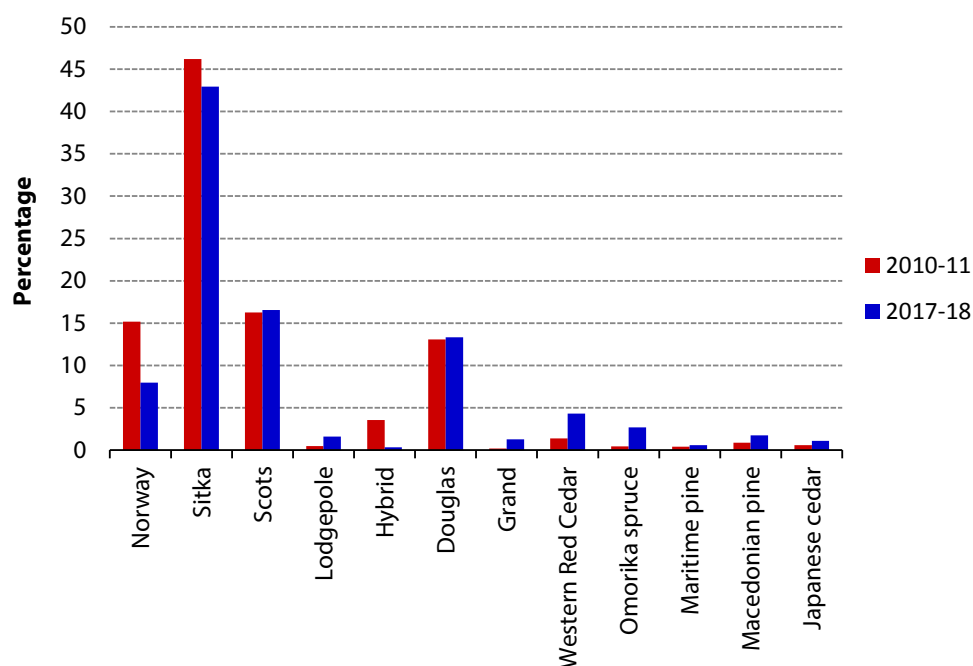


Source: Forestry England.

Notes: Other species for 2017-18 include grey alder 1.3%, wild service tree 0.5%, eucalyptus 0.5%.

The number of different conifer species planted on the Nation's Forests has also risen from 8 in 2012 - 2013 to 13 in 2017 - 2018 (figure 2.21).

Figure 2.21. Percentage of conifer species planted on the Nation's Forests

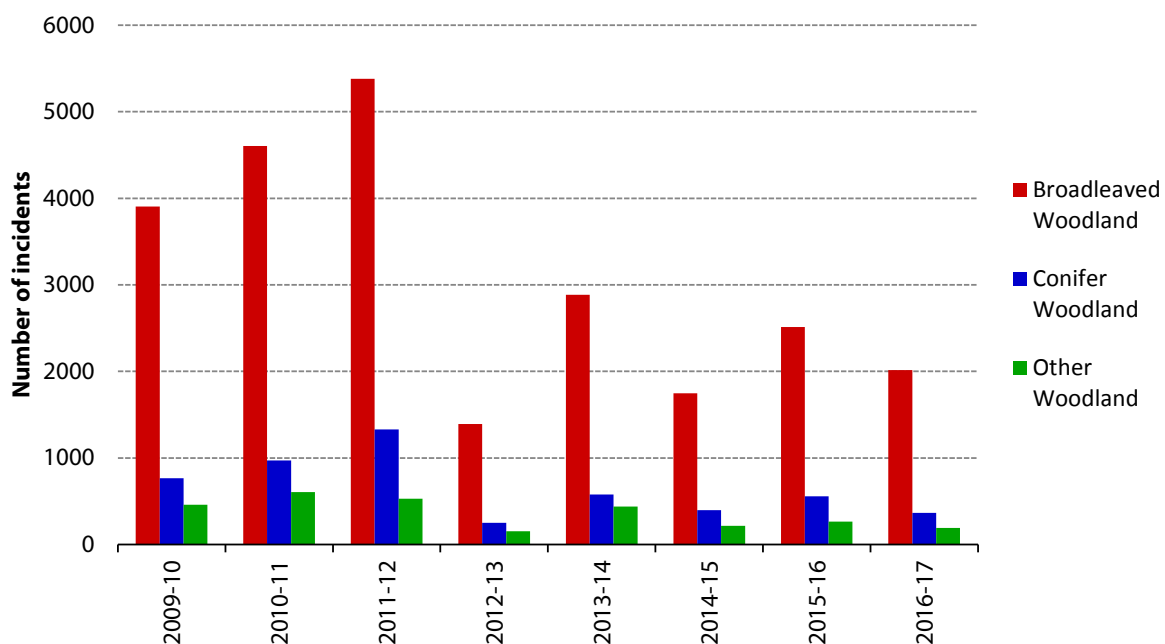


Source: Forestry England.

As outlined in section 2.2, projections of drier springs and summers with reduced soil moisture would suggest an increase in the frequency and areas affected by wildfires in the UK. The Forestry Commission publish statistics for wildfire incidents affecting forests that are attended by the Fire and Rescue Service (FRS) in England for the eight financial years 2009 - 2010 to 2016 - 2017 inclusive (see figure 2.22).¹¹⁵ This impact indicator shows that the number of wildfire incidents has been notably lower in the last five years (2012 - 2013 to 2016 - 2017) than in the three years prior to this (2009 - 2010 to 2011 - 2012). This may be linked to a change in seasonal conditions, with drought conditions were more prevalent over 2010 to 2012, compared with 2013 onwards. The latter period saw a return to more 'average' conditions and more frequent episodes of wet weather.

¹¹⁵ ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*.

Figure 2.22. Total number of wildfire incidents in woodlands in England recorded each year by the Fire and Rescue Services



Source: ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*.

Conclusion

Climate change adaptation plans, which contain clear actions and outcomes, do exist for the forestry sector. However, those that have been published lack targets and are near-term in risk outlook. Progress towards managing risk is mixed; the Forestry Commission's target for increasing the area of forest under active management has been missed, though the diversity of tree planting is still increasing.

2.9. Commercial fisheries and aquaculture

This adaptation priority considers how the fishing and aquaculture industry is adapting to future climate change. It focusses on measures to address changing species distribution (including the risks from invasive species) and disease risk so that the sector can continue to provide people with fish and shellfish as the climate changes. Changes in the marine environment (section 2.4) have a clear impact on fisheries, and here we consider additional indicators of changing commercial fish distributions and the extent to which populations are being managed sustainably. Vulnerability metrics for the aquaculture sector would be welcomed.

What is the risk?

CCRA2 notes that projected changes to water temperature, acidity and primary productivity are likely to have implications for marine fisheries and aquaculture.

While overall, the UK is expected to benefit from slightly higher fishery yields up to 2050, the Irish Sea and English Channel may see a reduction in yields by the end of this period. Models suggest that cod stocks in the Celtic and Irish Seas might disappear completely by 2100, while those in the North Sea are expected to decline. There is evidence, however, that higher temperatures will cause some warm-water demersal species to become more common in new areas (e.g. John Dory, Red mullet). UK-marine farmed species (aquaculture) may also become more susceptible to a wider variety of diseases as water temperatures increase.

A need to improve understanding of the social and economic implications for the UK fishing industry of changes in the distribution and abundance of fish stocks was identified as a research priority in CCRA2.

CCC progress score	Reason for progress score
2	Plan score - low: There are no plans at present that set out a strategy for adapting the commercial fisheries and aquaculture sector to climate change. Risk score - medium: • Fish stocks are becoming more exposed to increased sea temperatures over time. • Actions to manage fish stocks to maintain sustainable yields appear to be improving stock recovery. • There are no data available to measure changing vulnerability in the aquaculture sector.

Is there a good quality plan?

No published plans exist to improve the ability of the commercial fisheries and aquaculture sector to adapt to climate change. Draft proposals outlining post EU-exit plans for fisheries management in UK waters represent a step backwards from the current protections in place under the Common Fisheries Policy (CFP).

Are plans covered in NAP2?

There is no clear plan set out in NAP2 for improving the resilience of marine fisheries and aquaculture to climate change.

To support adaptation, policies for fisheries and aquaculture need to achieve at least two key aims: sustainable yields for populations; and flexibility through time in what species are caught, to mirror the changing species diversity and abundance in UK waters as the climate changes.

NAP2 makes reference to the Fisheries White Paper, which has been published ahead of the forthcoming Fisheries Bill and is currently passing through Parliament. The White Paper outlines the Government's plans for fisheries management once the UK leaves the EU. It includes an overarching aim to build 'a vibrant and sustainable UK fishing industry' by taking responsibility for managing fisheries resources within UK waters, while continuing to protect and improve the marine environment. However, whilst the plan includes a recognition of the need to adapt to the impacts of climate change, it provides no proposals on how this will be achieved.

The Fisheries Bill in its current form represents a dilution of ambitions outlined in the Government's own Fisheries White Paper, since it includes no legal duty to limit catches in line with scientific advice. For instance, clause 1 of the Fisheries Bill reiterates the commitment to apply the principle of Maximum Sustainable Yield (MSY) when setting or agreeing total allowable catches, and promote fishing within MSY ranges. However, in revoking Article 2 of the EU's CFP regulation, it removes the target to achieve an MSY-level of exploitation of fish stocks by 2020. Ensuring that fish stocks are recovered to scientifically-determined sustainable levels is redundant without a timescale. If we are to assume that the target date aligns to the timeframe of the 25-year Plan, this represents huge step backwards.

Are there other plans not mentioned in NAP2?

Outside of NAP2, no published plan currently exists for improving the resilience of marine fisheries and aquaculture to climate change.

Do the plans address the risks?

Current plans outlined in NAP2 do not support effectively the ability of the commercial fisheries and aquaculture sector to adapt to the likely distribution and abundance of fish stocks as a result of projected changes to sea water temperature, acidity and primary productivity.

Is progress being made in managing risk?

Are relevant actions taking place?

NAP2 includes some actions related to research and guidance, but does not include actions being taken by the fishing and aquaculture sectors themselves to reduce risk.

Direct measures of climate change exposure are available for UK seas showing average water temperature and acidification levels increasing over time. NAP2 actions include a number of studies that have investigated the consequences of these environmental changes for fisheries abundance, distribution and yield. For instance, the Marine Climate Change Impacts Partnership (MCCIP) has published a series of report cards (see also section 2.4) on how to manage protected marine species and habitats to help them adapt to climate change.¹¹⁶

¹¹⁶ <http://www.mccip.org.uk/impacts-report-cards/full-report-cards/>

Themes have included: observed shifts in the distribution of species, including commercial fish; physiological impacts of warming on fish species; and impacts of ocean acidification on fish and shellfish. In almost all cases the findings from the studies are confounded by variability in prevailing weather conditions, changes in fishing effort and fishing mortality, and shifts in preferred fisheries species over time. Nevertheless the information being gathered should soon provide effective indicators of climate change, climate change impacts and adaptation in fisheries.

Other actions outlined in NAP2 include a number of reports by Seafish, the industry body with a remit to support the profitability and sustainability of the seafood industry. The organisation is in the process of producing a climate change adaptation report. This will describe the steps that the fisheries and aquaculture sectors are taking to respond to climate change, focussing on risks and opportunities associated with climate change in the UK aquaculture sector (such as new species that can be cultured in warmer waters). Supporting desk-based research to review and assess climate change risk impacts relevant to the aquaculture industry has been completed along with stakeholder engagement to validate impacts and identify adaptation responses. The extent to which climate change warming scenarios are considered in the report is not known at this stage.

Seafish also published a report on their climate change adaptations as part of the second round of the adaptation reporting powers (ARP).¹¹⁷ The report sets out their progress in adapting to the current and future predicted effects of climate change on their organisation. Whilst the report does assess impacts from future changes in sea temperatures and increased storm volatility, the climate change scenarios under which these hazards are considered is not clear.

There is no information currently on the adaptation measures being taken by the aquaculture and fish farming industries.

Is there evidence that risk is being managed?

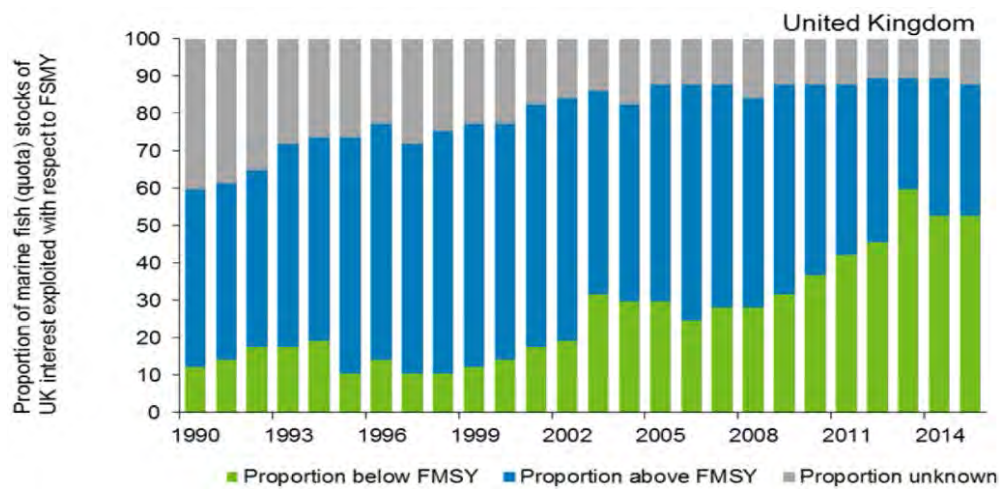
There is some evidence of an improvement in the health of UK fish stocks. This may be due to changes in the equipment used by the fishing industry under the CFP.

Under the CFP a number of tools are used to manage UK fisheries. These include minimum landing sizes; mesh sizes; effort control (limiting days at sea, or power of vessels); area closures; technical measures specifying aspects of the design of the gear; and landing restrictions. The primary means of controlling the amount of fish removed from a stock is by the setting of a Total Allowable Catch. Replacement policies for the CFP must ensure the gains made in improving the sustainability of the UK fishing industry are both maintained and built upon.

UK fish stocks are showing signs of recovery following their historic over-exploitation. The proportion of stocks fished at or below a level capable of producing maximum sustainable yield (MSY), and the proportion of stocks with biomass above the level capable of producing MSY, have increased significantly since 1990. The proportion of stocks fished at or below MSY remains significantly up over the long term; increasing from 12% in 1990 to 53% in 2015 (figure 2.23).

¹¹⁷ Garrett, A. Buckley, P. Brown, S (2015), *Understanding and responding to climate change in the UK seafood industry: Climate change risk adaptation for wild capture seafood Winter 2015/16*, A Seafish report to the UK Government under the Climate Change Adaptation Reporting Power.

Figure 2.23. Proportion of UK fish quota stocks harvested sustainably

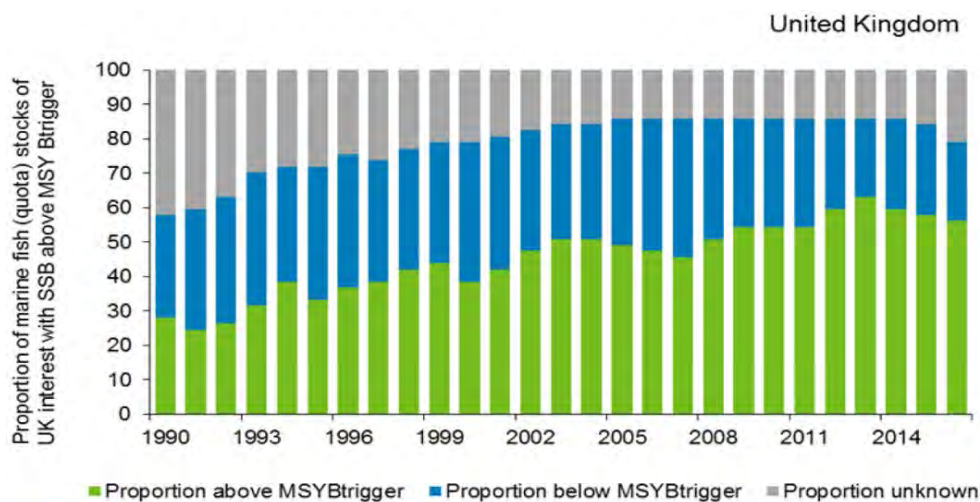


Source: Defra biodiversity indicators 2018 update.

Notes: Based on a group of 20 fish species in 57 stocks. The indicator stocks include a range of local and widely distributed species of major importance to the UK fishing industry. FMSY refers to stocks 'fished' at or below levels capable of producing 'maximum sustainable yield'.

To maintain the reproductive capacity of fish stocks, each stock's spawning biomass (SSB) should be at or above the level capable of producing MSY. The proportion of stocks achieving this goal increased from 28% in 1990 to 56% in 2016 (figure 2.24).

Figure 2.24. Proportion of UK fish stocks with biomass at levels that maintain full reproductive capacity



Source: Defra biodiversity indicators 2018 update.

Notes: Based on a group of 20 species in 57 stocks for which there are reliable estimates of fishing mortality and spawning biomass. The indicator stocks include a range of local and widely distributed species of major importance to the UK fishing industry.

Conclusion

There is currently no plan in place that represents a sufficient strategy for adapting the commercial fisheries and aquaculture sector to climate change. Some progress has been made under the CFP in introducing sustainable fisheries measures, and substantial research into the effect of climate change is underway. However, proposed reforms do not make enough consideration of climate change, and there is no explicit plan for how to manage fisheries and aquaculture effectively given the risks to marine environment outlined in CCRA2. Without an effective adaptation plan in place, exposure to changing sea temperatures is likely to have a significant negative influence on fish stocks, potentially driving unmanageable changes in species distribution and abundance.

Chapter 3: People and the built environment



3.1 Introduction

Over 90% of England's population live in urban areas¹¹⁸ and the second Climate Change Risk Assessment¹¹⁹ (CCRA2) identified that the most severe climate impacts will affect cities and towns – this chapter examines this issue. Many of these issues also apply to rural communities albeit with a lower level of exposure.

Flooding (Section 3.2), coastal erosion (Section 3.3), water availability (Section 3.4) and health impacts from heat, cold, pathogens and air pollution (Section 3.5) are all considered here as the key conduits for climate impacts on people in the built environment. The capacity of emergency responders to cope with climate-related emergencies is also considered (Section 3.6).

CCRA2 highlighted that a large number of diverse climate change risks impact upon people and the built environment. In contrast to some of the second National Adaptation Programme (NAP2) themes, there are no overarching national strategies or policies that focus on climate change adaptation for people and the built environment, but there are a range of policies and responses for specific risks. The large number of risks, plans, sectors and organisations involved in climate change adaptation in populated areas poses a challenge for coordination and implementation. A number of cities have responded by creating partnerships, such as the Leeds Climate Commission¹²⁰ that was founded in 2017, to take a more holistic approach in tackling risks at the city scale. These commissions are not yet sufficiently advanced or widespread to provide the basis of a nationwide assessment, but they may enable this in the future. Therefore, the CCC has, as in previous Progress Reports, examined policies and responses to specific risks.

3.2 Flood risk management and climate change

3.2.1 Introduction

This section on flood risk management begins with an analysis of the overall flood risk and response in the context of climate change and is then followed by analysis of the CCC's more specific adaptation priorities.

What is the risk from all sources of flooding?

In the absence of additional adaptation over and above today's levels, CCRA2 projected large increases in both the number of people at risk from flooding and in the costs related to flood damages in the future.

Analysis for CCRA2¹²¹ showed that 1,400,000 people in England currently face a 1:75 or greater flood risk (i.e. a 1.33% chance of flooding in any given year) and that direct Expected Annual Damages (EAD) to residential properties from flooding are currently £270 million.

¹¹⁸ Defra (2018) *Statistical Digest of Rural England*.

¹¹⁹ CCC (2016) *UK Climate Change Risk Assessment 2017 Evidence Report*.

¹²⁰ <http://leeds.candocities.org>

¹²¹ Sayers et al. (2015) *Climate Change Risk Assessment 2017: Projections of future flood risk in the UK*.

This covers all sources of flooding: river; coastal; surface water¹²²; and groundwater.¹²³ Assuming no population growth and a continuation of current levels of adaptation (i.e. the standard of protection provided by flood defences reduces in areas where the benefit-cost case is weakest, but is maintained in areas with the highest standards today), the analysis suggests that by the 2050s the projected number of people at a 1:75 year or greater risk rises to around 1,700,000 under a 2°C scenario and 2,200,000 for a 4°C scenario. For the 2080s, the projections suggest 2,000,000 people will be at risk under a 2°C scenario and 2,900,000 people under a 4°C scenario. EAD for residential properties is projected to rise by 22 – 78% in the 2050s and 47 – 160% in the 2080s depending on the climate scenario used in the analysis.

CCRA2 concluded that there is likely to be a significant adaptation shortfall in the future. Under the most ambitious adaptation investment scenario for England the level of risk declines compared to present day (assuming no population growth) but remains at high magnitude by mid-century. The risk cannot be reduced relative to present day under any adaptation scenario considered in CCRA2 in a 4°C world. This is the background against which the Government needs to revise an adaptation strategy for flooding.

Is there a good quality plan that presents a response to England's overall flood risk?

A national, long-term, outcomes-based adaptation strategy to address the increasing flood risk identified in CCRA2 is still required.

The CCC's Progress Reports from 2015¹²⁴ and 2017¹²⁵ called for such a strategy to be developed. The second National Adaptation Programme¹²⁶ (NAP2) repeats the 25 Year Environment Plan's goal 'to reduce the risk of harm to people, the environment and the economy from natural hazards including flooding' but it does not explain what this means in terms of protection and resilience, for example, and includes no actions that directly contribute to meeting this goal. NAP2 does include actions related to the production of other documents that may include an adequate strategy within them. Indeed, one of those draft plans – the Draft National Flood and Coastal Erosion Risk Management (FCERM) Strategy for England – has taken on board some of the CCC's recommendations regarding planning for climate change (Box 3.1). The draft strategy is revisited briefly where relevant throughout this chapter. Importantly, there is no requirement for plans outside of the NAP to address the CCRA2 risks directly.

¹²² Surface water flooding is considered separately from river and coastal flooding in this chapter. There are different policies, plans, actors and responses for these two categories of flooding that make their separation in this report, as well as in policy making, convenient. Nonetheless, there are also interactions and overlaps that should not be ignored. These include: policy (all flooding sources are covered in some plans e.g. the FCERM Strategy); flood defence and resilience funding streams cover all sources of flooding; and physical drivers are not completely unique for different flooding sources e.g. high rivers and rising sea levels can lead to drainage blocking as water can't drain away.

¹²³ Groundwater flooding is not examined in this report as there are few data and policies to examine. This issue requires further research.

¹²⁴ CCC (2015) *Progress in preparing for climate change – 2015 Report to Parliament*.

¹²⁵ CCC (2017) *Progress in preparing for climate change – 2017 Report to Parliament*.

¹²⁶ Defra (2018) *The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting*.

Box 3.1. The Environment Agency's Draft National Flood and Coastal Erosion Risk Management (FCERM) Strategy for England

The Environment Agency's draft FCERM Strategy includes a number of high-level 'Strategic Objectives' that outline broad goals out to 2030-2050 (see list below). In comparison to the objectives from the 2011 FCERM Strategy, these are a more specific and evidence-based perspective on medium- to long-term planning and have the potential to form an overarching national strategy that extends beyond just the Environment Agency's role. The objectives largely address the relevant flooding and coastal erosion risks from CCRA2. Some objectives are in line with previous CCC recommendations (e.g. 1.2, 2.6, 3.3) whilst others require more detail and commitment from other partners before they can be assessed or implemented properly (e.g. 1.1, 1.5).

The inclusion of success criteria and the quantification of targets (e.g. the length of coast to be re-aligned by 2030, or the number of properties to receive property-level flood resilience measures by 2025) are still missing but the list of objectives (see below) comes closer than any previous plan to addressing the climate change risks in this area. Beneath those objectives, a number of 'Measures' are described that put together actions for the period to 2030. Where appropriate, these draft Measures have been referred to in this Progress Report. The draft strategy still has to be finalised following a consultation period and then must be aligned with the Defra Policy Statement and approved by the Secretary of State for Environment, Food and Rural Affairs. The CCC, in its next progress report in 2021, will assess the extent to which the final strategy and associated actions are preparing the country for the changing flood risk that will arise from a 2°C rise in global temperature as a minimum and will also consider scenarios up to 4°C.

Draft FCERM Strategic objectives:

1.1: Between now and 2050 the nation will be resilient to future flood and coastal risks. Over the next year the Environment Agency will work with partners to explore and develop the concept of standards for flood and coastal resilience.

1.2: Between now and 2050 risk management authorities will help places plan and adapt to flooding and coastal change across a range of climate futures.

1.3: Between now and 2030 all those involved in managing water will embrace and embed adaptive approaches to enhance the resilience of our environment to future flooding and drought.

1.4: Between now and 2030 risk management authorities will enhance the natural, built and historic environments so we leave it in a better state for the next generation.

1.5: Between now and 2030 risk management authorities will use funding and financing from new sources to invest in making the nation resilient to flooding and coastal change.

2.1: Between now and 2030 all new development will contribute to achieving place based resilience to flooding and coastal change.

2.2: Between now and 2030 all new development will seek to support environmental net gain in local places.

2.3: Between now and 2030 all risk management authorities will contribute positively to local economic regeneration and sustainable growth through their investments in flooding and coastal change projects.

2.4: Between now and 2050 places affected by flooding and coastal change will be 'built back better' and in better places.

2.5: Between now and 2030 all flooding and coastal infrastructure owners will understand the responsibilities they have to support flood and coastal resilience in places.

Box 3.1. The Environment Agency's Draft National Flood and Coastal Erosion Risk Management (FCERM) Strategy for England

2.6: Between now and 2050 the Environment Agency and risk management authorities will work with infrastructure providers to ensure all infrastructure investment is resilient to future flooding and coastal change.

3.1: Between now and 2030 young people at 16 should understand the impact of flooding and coastal change, but also recognise the potential solutions for their place, and opportunities for career development.

3.2: Between now and 2030 people will understand the potential impact of flooding and coastal change on them and take action.

3.3: Between now and 2030 people will receive a consistent and coordinated level of support from all those involved in response and recovery from flooding and coastal change.

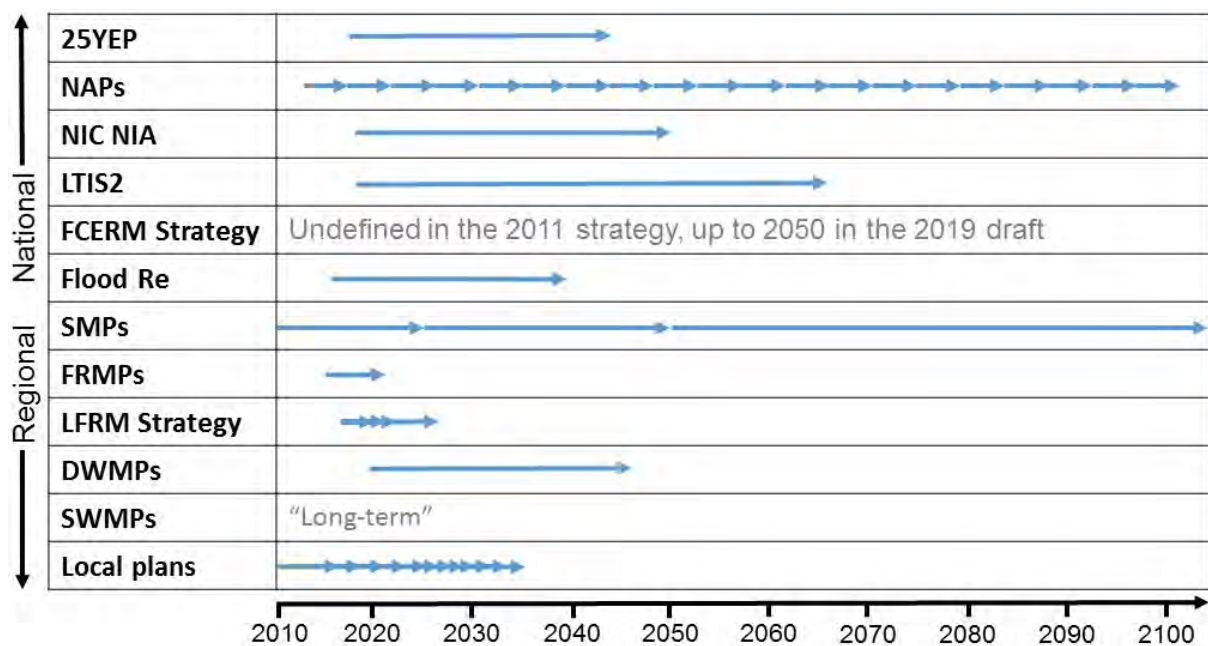
3.4: Between now and 2030 the nation will be recognised as world leader in managing flooding and coastal change, as well as developing and attracting talent to create resilient places.

Source: The list of objectives has been taken from Environment Agency (2019) *Draft Flood and Coastal Erosion Risk Management Strategy*.

There are already several plans attempting to tackle different sources, or combinations of sources, of flooding (Figure 3.1) but none of these plans represents a statutory, long-term strategy that addresses the likely climate change risks. The heterogeneous time and spatial scales covered by these various plans does not create the conditions for a coherent adaptation strategy for flood risk. Objectives and actions that are currently being developed in various new plans¹²⁷ may not complement each other or existing plans. Given the NAP's place within the Climate Change Act, this would have been the ideal document to include a clear strategy to align other plans, but that opportunity has been missed for 2018 - 2023.

¹²⁷ These are: the Environment Agency's updated draft national Flood and Coastal Erosion Risk Management (FCERM) strategy; the delayed Defra policy statement; and the implications of HM Treasury's potential acceptance of the National Infrastructure Assessment recommendations on flooding.

Figure 3.1. Temporal and spatial mismatch between different plans and policies relating to flooding



Notes: These timelines show how different plans relating to Flood and Coastal Erosion Risk Management (FCERM) and housing development planning do not align. Consecutive arrows (i.e. for NAPs and SMPs) indicate renewals or different phases of plans. Overlapping arrows (i.e. for local plans and LFRM strategies) indicate where plans in different areas or regions have different active periods. The plans are: the 25 Year Environment Plan (25YEP) that sets out broad goals for the period 2018 - 2042; the National Adaptation Programmes, which cover consecutive 5 year periods that respond to CCRA; the National Infrastructure Commission (NIC) makes recommendations on long-term infrastructure needs every Parliament in their National Infrastructure Assessment (NIA) that may be accepted by the Government in their National Infrastructure Strategy; the Long-term Investments Scenarios (LTIS, discussed below); the Environment Agency's national FCERM Strategy, which is currently being updated (Box 3.1), but the 2011 version included no targets or ambitions linked to any particular timescale; the Flood Re re-insurance scheme (Box 3.2) is active until 2039; the Shoreline Management Plans (SMPs) outline sustainable futures for the English and Welsh coast, split into 22 segments; the Flood Risk Management Plans (FRMPs) cover the river basin districts; the Local Flood Risk Management (LFRM) Strategies are where lead local flood authorities (LLFAs) develop objectives to manage all sources of flooding locally; the Drainage and Wastewater Management Plans (DWMPs) are developed by water and sewerage companies; the Surface Water Management Plans (SWMPs) are where local authorities plan for surface water flood risk; and the local plans outline each local authority's plan for housing development in their areas, which do not align with river catchment areas or districts, nor the SMP or DWMP areas.

The National Adaptation Programme should outline actions that directly address flood risk, but this has not been done in NAP2.

As well as the lack of an overall vision or strategy from NAP2, it is also lacking in actions that directly address flood risk. Of the 10 FCERM actions in NAP2, there are: three actions that relate to the ongoing production or refresh of other documents; two actions that relate to new or updated datasets; one action to review funding arrangements; one to continue 'supporting' an external initiative; one to 'ensure' that an existing policy is effective; and one action that contains no obvious action.¹²⁸

¹²⁸ 'Historic England Appleby Heritage Action Zone. Flood resilience and recovery in historic and traditionally constructed buildings' is ambiguous about what action or actions are being implemented.

The final action relates to the delivery of the existing surface water management action plan, which itself contains 22 actions that, in general, all relate to data issues or reviews and clarifications of existing plans and working arrangements – this action plan is discussed further in Section 3.2.3. Even if all these NAP2 actions are implemented within the planned timeframe, there will be no direct impact on reducing flood risk. While improving understanding and building capacity are important parts of the adaptation response, they are insufficient on their own to manage risk. There is also an important initiative that is absent from the NAP2 actions: Flood Re (see Box 3.2). This temporary scheme is due to be withdrawn in 2039 and it is concerning that there are no NAP2 actions for the period 2018 - 2023 that address the withdrawal process.

Box 3.2. Flood Re

Flood Re was launched in 2016 as a not-for-profit re-insurer (i.e. insurance for insurers) to cover flood risk in the UK. The scheme allows insurers to choose to have the flood risk element of any policy they offer re-insured by Flood Re for a fixed price linked to the property's council tax band. If re-insured properties make a flood loss claim successfully then Flood Re will reimburse the insurer for the pay-out. Its aim is to keep flood insurance affordable for householders that face a high flood risk until 2039 when Flood Re will be withdrawn and the insurance market should become risk-reflective. Up to 2039, properties that face high flood risk should be adapted in such a way that they can be affordably insured in a risk-reflective marketplace and/or are sufficiently resilient to the impacts of flooding. This process requires management and monitoring but has not been addressed in NAP2. Flood Re's service is not available for properties built since 1 January 2009, or businesses.

Is progress being made in managing overall flood risk?

The Government's £2.6 billion, six-year (2015 - 2021) investment programme¹²⁹ in flood and coastal erosion risk management has been consistent with the Environment Agency's 2014 analysis of the level of investment needed for FCERM,¹³⁰ but more recent analysis shows that the level of investment needs to increase.

The Environment Agency's 2014 Long-Term Investment Scenarios (LTIS) assessed the costs and benefits of different levels of annual expenditure on flood risk management, including an assessment of future climate change. The analysis concluded that an average annual spend of £750 – 900 million between 2015 and 2065 provided the optimum level of benefits in relation to costs. The Government spent in line with this optimum amount in its most recent six-year programme.

However, the 2019 update of that investment analysis¹³¹ (LTIS2), which incorporates a wider range of climate change scenarios and more adaptation approaches, shows that increased investment will be required after 2021 to maintain that optimum cost-effective investment path to manage flood risk in England. This new level of investment should be addressed in the post-2021 FCERM funding arrangement review, which is a NAP2 action.

If this is not addressed (and/or the transition of Flood Re is not efficient) then there is likely to be an increase in the number of high-flood-risk properties in England that are uninsurable.¹³² More

¹²⁹ Note that this covers flood alleviation for all sources.

¹³⁰ Environment Agency (2014) *Flood and coastal erosion risk management: long-term investment scenarios (LTIS) 2014*.

¹³¹ Environment Agency (2019) *Long-term investment scenarios (LTIS) 2019*.

¹³² Flood Re (2018) *Securing a future of affordable flood insurance*.

effective long-term planning will be possible if this post-2021 funding arrangement is allocated as early as possible and if the outcome measures used in the funding algorithm are expanded to incorporate a wider range of benefits beyond the current main focus of the number of homes protected. Achieving this looks possible if Measures 1.1.1 and 1.4.1 of the draft FCERM Strategy¹³³ are implemented effectively.

The flood risk management schemes delivered from the six-year investment programme have improved protection for 144,000 homes between April 2015 and April 2018, but it is currently not possible to tell if this rate of investment and protection is sufficient to maintain the current level of risk. Data are needed on the change in risk bands that different properties are falling into over time to analyse the change in risk.

This increase in protection is on-track with the programme's target to provide better protection for 300,000 homes before 2021. There is, however, little published evidence to indicate whether better protecting 300,000 homes per six-year period (or 50,000 homes per year) is adequately managing the increasing flood risk from climate change and other factors, because of a lack of data showing what risk level these homes are moving out of, and into.

The calculation of annual projected increase in exposure due to climate change could be done by using the detailed LTIS2 findings or by using the research that fed into CCRA2.¹³⁴ The latter shows that, depending on the scenario modelled, around 9,000 - 30,000¹³⁵ extra homes per year between 2015 and 2055 would move into the 1:75 year risk category (i.e. 1.33% annual probability of flooding) when previously they had a lower flood risk. In order to understand whether the Government's investment programme is keeping up with that projected increase in exposure, we would need a more detailed analysis of the 300,000 homes that were better protected. Specifically, the 300,000 figure needs to be categorised by how much the risk level has changed as a result of each intervention. If the number of homes that are newly protected to a 1:75 level each year is less than 9,000 homes, say, then we know that exposure in that risk band is almost certainly increasing year-on-year as it is lower than the most optimistic model scenario from CCRA2. At present, the data required to perform such a calculation are not available. This kind of analysis, based on projected future risk levels and the details of flood management interventions, is needed to develop a plan for flood risk management that directly addresses different future climate scenarios.

Conclusion

The plans and actions that address all forms of flooding in England are delivering some valuable results but more work is required to develop a robust plan to respond to the increasing risks from climate change.

The sections below split the issue out into different types of flooding (river, coastal and surface water) or different types of adaptation, for which we provide scores based on our assessment framework (see Chapter 1).

¹³³ Environment Agency (2019) *Draft Flood and Coastal Erosion Risk Management Strategy*.

¹³⁴ Sayers et al. (2015) *Climate Change Risk Assessment 2017: Projections of future flood risk in the UK*.

¹³⁵ The low end of this range comes from the 2°C climate change, 'baseline' adaptation interventions and a low population scenario and the high end from the 4°C climate change, high population, reduced adaptation scenario.

3.2.2 River and coastal flood alleviation

What is the risk?

Research for CCRA2¹³⁶ showed that the number of people in England exposed to a 1:75 year, or 1.33% annual probability, of river and coastal flood risk could increase from around 750,000 at present to up to 4,200,000 in the 2080s.

This latter estimate for the 2080s is derived from a 4°C global temperature rise by 2100, reduced adaptation interventions and high population growth scenario used in the CCRA2 flooding projections project.¹³⁷ The increase in exposure, however, could be kept as low as 950,000 people in a 2°C world where the adaptation responses in England are enhanced and population growth is low. There are many other flood risks to property, infrastructure, the environment and society that are not captured in these estimates.

CCC progress score	Reason for progress score
5	Plan score - medium: Although there are several different plans for managing different aspects of flood risk, there is currently no overarching plan with associated outcomes and targets that brings these different strands together, including for the management of river and coastal flooding. The investment in flood risk management actions for 2015 - 2021 relative to the previous six-year period was in line with an optimum investment pathway published by the Environment Agency in 2014. This level of investment will need to increase based on the Environment Agency's 2019 update of the cost-benefit investment analysis of the optimum level of spend to manage increasing risk. Climate change 'allowances' are in place that ensure new flood defences take future changes in climate into account in assessing the standards they need to be built to. Risk score - medium: The condition of 'high consequence' flood defences is now meeting the required maintenance standards set out by the Environment Agency. It is not possible to assess whether progress in protecting properties is keeping up with the rate that climate change, and other factors, are increasing the number of properties exposed to flood risk.

¹³⁶ Sayers et al. (2015) *Climate Change Risk Assessment 2017: Projections of future flood risk in the UK*.

¹³⁷ Ibid.

Is there a good quality plan?

Are plans covered in NAP2?

NAP2 includes no plans or actions in the FCERM section that directly address flood risk. NAP2 instead signposts other plans which do not currently, and are not required to, respond to the CCRA2 risks.

NAP2 largely points to other, ongoing planning initiatives in this area, such as: the Environment Agency FCERM Strategy update (Box 3.1); publication of a Defra FCERM Policy Statement, though this has been delayed from the 'winter 2018' timing outlined in NAP2; and the Environment Bill, which aims to (among other things) formalise the vision of the 25 Year Environment Plan. NAP2 should directly address the risks identified in the CCRA2: signposting other plans and strategies which are not required to, and do not, consider the specific set of CCRA2 risks does not meet the NAP's objectives.

Are there are other plans not mentioned in NAP2?

There are a number of plans and strategies related to river and coastal flood alleviation but they do not currently have well-defined outcomes or targets with respect to managing climate risks. The range of potential impacts from different levels of climate change are not currently considered in these plans. There is an important opportunity to do this under the new draft FCERM strategy, being led by the Environment Agency.

The 2011 Environment Agency national FCERM Strategy¹³⁸ set out some general aims and ambitions with the key one being to 'ensure the risk of flooding and coastal erosion is properly managed'. This type of general aim does not enable progress towards a target, or targets, to be assessed. The overall 2011 strategy aim quoted above was broken down to some extent but not to the level of discrete actions. The active timescale of the strategy was not defined, nor were the ways in which risk management might have to change to respond to a changing risk profile from climate change. Whilst the issue of climate change is acknowledged in the document, there were no specific strategies outlined that would address a changing and uncertain flood risk profile in the future.

Outside of the strategy, however, climate change allowances are in place that ensure new flood defences use high emissions scenarios for climate change (equivalent to between a 3.4°C and 5.3°C rise in global temperature by 2100, depending on the probability level used) in assessing what standard they need to be built to.¹³⁹ It is not clear how far this planning for a high climate scenario extends to other aspects of flood risk management besides flood defence design.

As described in Box 3.1, the Environment Agency's FCERM Strategy is being updated. The draft strategy includes a proposal (Measures 1.2.1, 1.2.3 and 1.2.5) to develop adaptation pathways for a number of test cases. Assuming that these pathways are focussed on appropriate spatial scales (i.e. where there are not too many interacting hazards that complicate the identification of clear trigger events), then this approach is well suited to situations where the magnitude of the future changes are uncertain and is in-keeping with the draft strategy's approach of being able to adapt to a range of future climates, including 4°C.

¹³⁸ Environment Agency (2011) *National flood and coastal erosion risk management strategy for England*.

¹³⁹ <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

The approach encourages planners to consider a range of environmental and socioeconomic changes on different timescales alongside the potential responses and what particular events would trigger their implementation. If these local planning pathways are aligned with a well-articulated national goal then they would form the basis of a long-term, yet flexible, strategy. Measures 2.1.1 and 2.1.2 of the draft strategy aim to facilitate these local pathways by proposing investments in capacity and skills to improve collaboration between the lead local flood authorities (LLFAs) and local planning authorities.

There is a lack of national, climate change scenario-driven future flood risk maps.

The absence of such maps and data makes nationally consistent, long-term planning problematic as there is no standard set of spatial risk levels for planners to apply that account for climate change. This needs to be rectified. Measure 1.2.2 of the draft, updated FCERM Strategy¹⁴⁰ proposes to implement this by 2024, which is very positive, although there is no NAP2 action to develop a national map of future flood risk.

Do the plans address the risks in CCRA2?

NAP2 does not directly address the risks from CCRA2, though other plans begin to.

Other plans start to address some CCRA2 risks but not in a coordinated way. The main omission is the linking of the aims and objectives of the plans back to the CCRA2 risks; it would be valuable if this could be done in the updated Environment Agency FCERM Strategy. The strategy should set out how it is addressing the adaptation shortfall identified in CCRA2, and whether the actions outlined in the strategy will mean that the country can adapt to a minimum 2°C global temperature scenario, with potential pathways identified to prepare for a 4°C scenario.

Is progress being made in managing risk?

Are relevant actions taking place?

NAP2 contains a set of actions related to river and coastal flooding, but none of these will directly reduce risk.¹⁴¹

However, the draft, updated FCERM Strategy (the production of which is included as a NAP2 action) includes some actions that will reduce river and coastal flood risk (Box 3.1). Objectives and Measures like those in the draft (i.e. with some specific actions included to address risk) will need to be included in the finalised version of the strategy for NAP2 to achieve its function of addressing CCRA2 risks.

The Environment Agency's six-year FCERM investment programme has delivered a large number of risk management interventions.¹⁴²

From April 2017 to March 2018, 184 FCERM schemes were completed, of which 92 improved protection from the risk of flooding from rivers and 31 improved protection from the risk of flooding from the sea. These schemes include interventions such as: flood walls and barriers, embankments, flood storage reservoirs, pumping stations, beach management, and natural flood management.¹⁴³

¹⁴⁰ Environment Agency (2019) *Draft National Flood and Coastal Erosion Risk Management Strategy for England*.

¹⁴¹ NAP action update – appendix A

¹⁴² <https://environment.data.gov.uk/asset-management/index.html>

¹⁴³ Environment Agency (2017) *Managing flood and coastal erosion risks in England: 1 April 2011 to 31 March 2017*.

These schemes have improved flood protection for 144,000 homes between April 2015 and April 2018, though as set out above, data regarding which risk bands these homes have moved out of, and into, for the different types of flooding including river and coastal flooding is not currently published.

Section 2.6 (water management) in the Natural Environment chapter of this report refers to natural flood management.

Is there evidence that risk is being managed?

The FCERM sector in England is well-developed and there are ongoing actions to address flood risk.

However, the extent to which these actions will manage increasing vulnerability and exposure from future development and climate change combined is not well analysed. The calculation required is possible with the right data, but it has not yet been done, as outlined above.

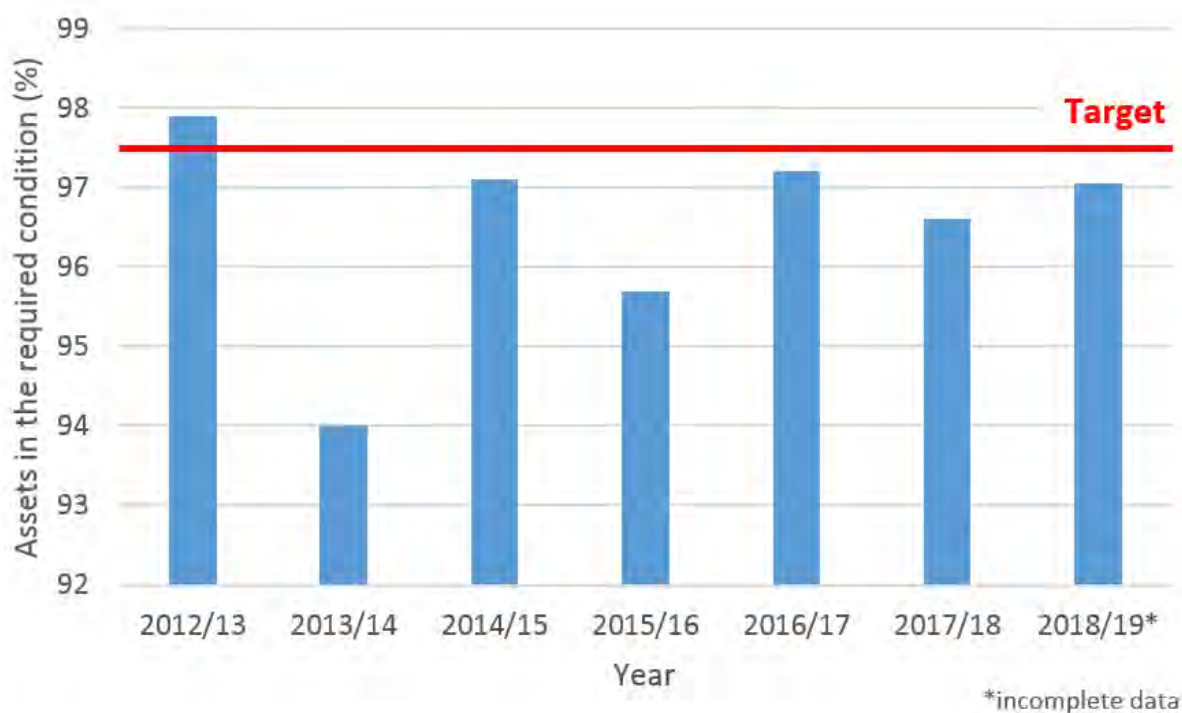
It is essential that flood defence assets are maintained to a high standard. Asset condition data¹⁴⁴ show that the Environment Agency has now met their 2019 target of having 97.5% of 'high consequence' assets in the required condition.¹⁴⁵ They are forecasting to meet their target commitment of 98% by April 2020.

Flood defence assets are structures or features that reduce flood risk, such as flood walls, embankments, culverts and pumping stations, amongst others. The average percentage of assets assessed each year that meet the target maintenance condition since 2013/14 is 96.5% (Figure 3.2). The latest data for 18/19 shows that the target has now been exceeded, as condition has reached 97.9%. More investigation into the small percentage of assets that fail to meet target condition would be useful to understand whether they are repaired/maintained quickly once they fall below target condition, whether certain assets persist in poor condition or whether asset repair is prioritised on a risk-basis so those most critical for risk management are repaired first.

¹⁴⁴ Environment Agency corporate scorecard <https://www.gov.uk/government/collections/environment-agency-corporate-scorecard>

¹⁴⁵ The definition of 'high consequence' and the required condition, as well as the inspection process, is set out in Environment Agency (2014) *Asset performance tools – asset inspection guidance*.

Figure 3.2. Flood defence asset condition



Source: Environment Agency corporate scorecard <https://www.gov.uk/government/collections/environment-agency-corporate-scorecard>

Notes: Annual averages of quarterly data on the number of assets at or above the target condition. At the time of writing there was only data available for Q1 and Q2 of 2018/19, but updated data now shows the target has been met. Note that the y axis starts at 92% to show the percentage in each year more clearly.

Conclusion

Whilst actions are occurring, it is not possible to assess how well these are managing changes in risk. There are no plans that set out quantified targets for future adaptation. Further analysis is required on how risk will change in the future and how this should inform decisions on a national outcome and strategy for flood risk alleviation.

Both the National Infrastructure Commission (NIC¹⁴⁶) and the Environment Agency¹⁴⁷ have proposed the adoption or exploration of national minimum standards of resilience. The Committee broadly support such ambitions but these standards must account for climate change, and acknowledge where certain standards of protection or resilience may be unrealistic to deliver.

¹⁴⁶ NIC (2018) *National Infrastructure Assessment 2018*.

¹⁴⁷ Environment Agency (2019) *Draft National Flood and Coastal Erosion Risk Management Strategy for England*.

3.2.3 Development in areas at risk of river or coastal flooding

What is the risk?

As well as considering changes in the vulnerability of existing development and people (see Section 3.2.2 above), research for CCRA2¹⁴⁸ showed that the number of residential properties in England exposed to a 1:75 year, or 1.33% annual probability, of river and coastal flood risk could increase from around 400,000 at present to over 2,000,000 in the 2080s.

This highest estimate for the 2080s is a result of a 4°C global temperature rise, reduced adaptation interventions and high population growth scenario used in the CCRA2 project. The number of homes exposed to a 1:75 year risk could be kept as low as 530,000 in a 2°C world where the adaptation responses in England are enhanced and population growth is low. Within this range there is significant potential for planning policy to reduce future exposure to flood risk – CCRA2 noted that around 250,000 new homes were built on the floodplain between 2001 and 2014.

CCC progress score	Reason for progress score
3	Plan score - medium: Processes are in place to restrict development in areas of significant river or coastal flood risk, though advice from the Environment Agency on where to restrict development can be overturned. These processes do not consider the increased risks from climate change in a consistent way as there is no national map that can be used for planning that shows projected future flood risk. Risk score - low: Exposure to flooding through new development is increasing. A relatively small number of properties are built each year in areas of significant flood risk that are not well-protected, against Environment Agency advice – though this is still increasing the number of properties in high risk categories over time. A much higher number of properties are built in at-risk areas where flood protection is currently in place, which will limit present day impacts but still increases the number of properties and people vulnerable to flooding now and in the future. Assessments need to be made as to whether those defences will be sufficient to manage future risks.

¹⁴⁸ Sayers et al. (2015) *Climate Change Risk Assessment 2017: Projections of future flood risk in the UK*.

Is there a good quality plan?

Are plans covered in NAP2?

NAP2 states that the Government will ‘Work to ensure that national planning policy [is] effective in managing the risks and impacts of flooding and coastal erosion. (This includes strengthening flood protections in the National Planning Policy Framework to ensure that new development is flood resilient and does not increase flood risk.)’.

Further details, and more specific actions, on how the effectiveness will be ensured are not provided in the NAP. There is also no mention of how climate change will be accounted for.

Are there other plans not mentioned in NAP2?

National planning policy¹⁴⁹ steers development away from current flood risk areas, and advises that future risk should be considered. However, doing this at present is problematic as there is no standard, national map of future flood risk.

Planning applications that are subject to river and coastal flood risk have a series of logical tests applied to them relating to: identifying more appropriate areas for development; the potential flood risk impact on other areas from the new development; and the impact from current and future flood risk. This planning process has not changed significantly since our last progress report¹⁵⁰ and more detailed discussion can be found there regarding the process. As noted in the 2017 Progress Report, new homes built after 1 January 2009 are excluded from the reinsurance scheme Flood Re, which could incentivise new development to be located away from flood risk areas and/or to include flood resilience measures (see Section 3.2.5). However, we have no evidence (and are aware of none being collected) to indicate that this has influenced where developers try to locate new developments.

Do the plans address the risks in CCRA2?

The guidance in the NPPF to plan for future risk should be supported by national spatial assessments of future flood risk that address the level of risk identified in CCRA2. Without a nationally accepted approach to assessing risk for new developments, different areas could apply different risk criteria and fail to consider the full range of climate risks.

Is progress being made in managing risk?

Are relevant actions taking place?

The number of planning applications approved against Environment Agency advice per year has been below 5% for the last 12 years.

When planning applications are made for developments in areas of river and/or coastal flood risk, these applications are referred to the Environment Agency for advice. The number of applications¹⁵¹ that have been granted against the Environment Agency’s advice has been between 50 and 100 applications per year since 2009/10 (Figure 3.2). This is approximately 3-4% of Decision Notices received by the Environment Agency relating to flood risk objections per year.

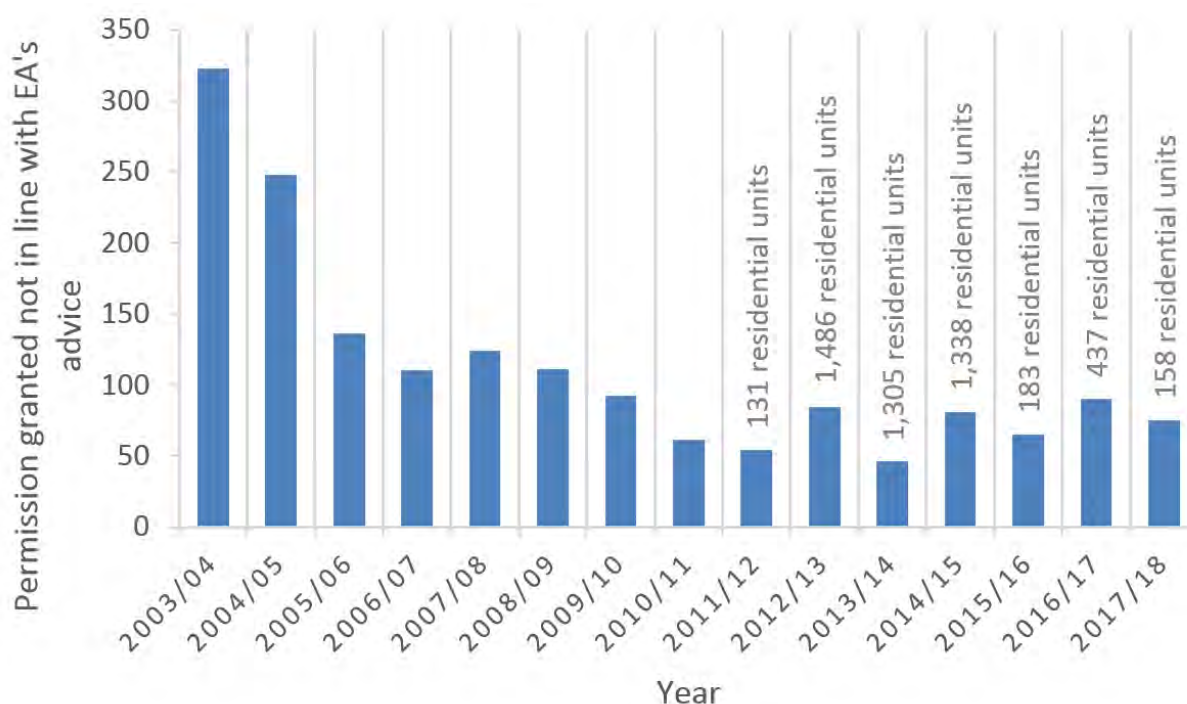
¹⁴⁹ MHCLG (2019) *National Planning Policy Framework*.

¹⁵⁰ CCC (2017) *Progress in preparing for climate change – 2017 Report to Parliament*.

¹⁵¹ Applications usually consist of multiple residential units, some in the hundreds.

This is not a high percentage but still represents a total of 1,200 developments since 2003/04 (or 5,038 residential units¹⁵² from 495 developments since 2011/12, which is the date from which we have data on the residential units) that have been granted permission against Environment Agency advice. These all contribute to increasing flood risk exposure.

Figure 3.2. Planning permissions not in line with Environment Agency advice



Source: Environment Agency.

Notes: Number of Decision Notices that are granted where the Agency have advised otherwise. From 2011/12 onwards there are also data relating to the number of residential covered by the planning applications – these data are included as text above the bars.

Is there evidence that risk is being managed?

As well as some properties being built in areas at risk against Environment Agency advice, those that are built in line with its advice are often by located in areas at flood risk where defences are currently in place. Assessments need to be made as to whether those defences will be sufficient to manage future risks.

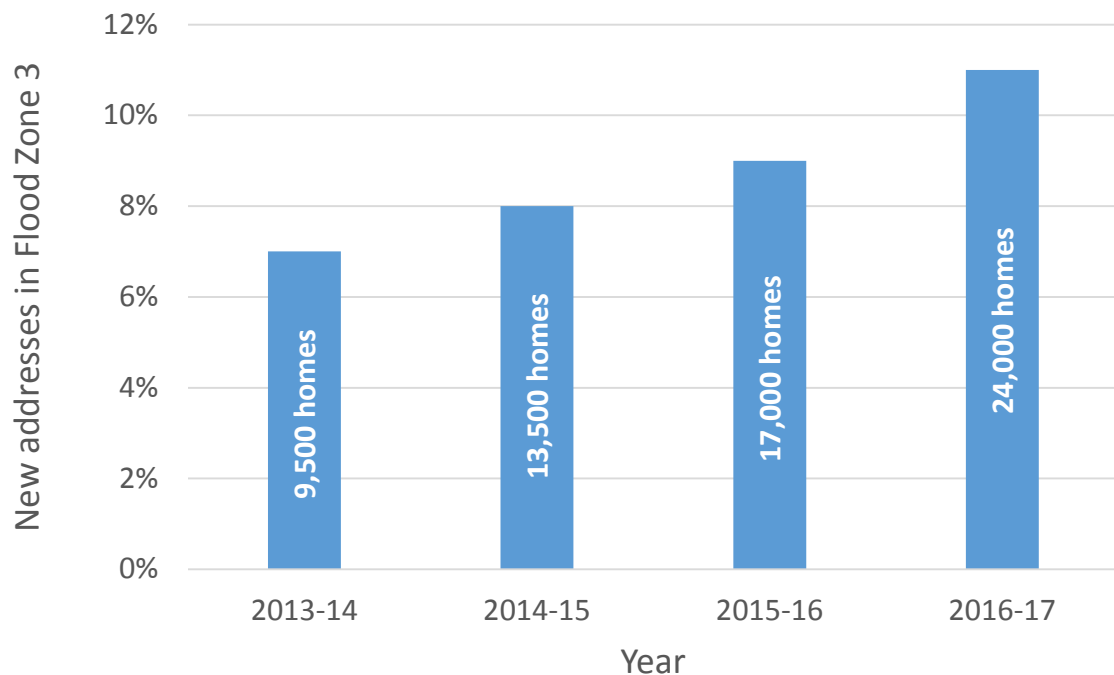
Developments in the floodplain that are currently protected by flood defences may not be subject to an Environment Agency objection because of the level of protection currently provided. Those properties could flood if defences fail, are breached/overtopped or are not maintained in the long-term. Eleven percent of new addresses in 2015/16, which equates to 23,900 properties, were built in Flood Zone 3¹⁵³ (Figure 3.3).

¹⁵² This is essentially a house or a flat.

¹⁵³ Flood Zone 3 covers areas with a greater than 1:100 year risk (1% annual probability) of river flooding or a greater than 1:200 year risk (0.5% annual probability) of flooding from the sea. The effect of flood defences is not considered in this calculation.

This percentage has increased steadily from seven percent in 2013/14 and, since that year, over 64,000 properties have been built in Flood Zone 3. If this 7 - 11% range continues until 2022/23, and the Government meets its target to build 300,000 new homes in England per year into the mid-2020s¹⁵⁴, then there is the possibility of building between 105,000 and 165,000¹⁵⁵ more homes in Flood Zone 3 between 2018/19 and 2022/23.

Figure 3.3. Development in Flood Zone 3



Source: Data from MHCLG (2018) *Land Use Change Statistics in England: 2016-17*.

Notes: The percentage (bars) and number (text) of new properties built in Flood Zone 3 in each year from 2013/14 to 2016/17.

Whilst limited and targeted building in Flood Zone 3 will not create a large present day increase in flood risk – many of these properties will be located in well-protected areas e.g. London, where protection to a 1:1000 year level, or 0.1% annual probability, is common – it still increases exposure in the event of defence breaches or overtopping. More fundamentally, this approach makes certain assumptions regarding the lifetime of housing developments and about the lifetime of defences and the scale of climate change in the latter years of those property lifetimes that have implications for future vulnerability. These problems need to be addressed in an overarching, flood risk strategy either in the NAP or elsewhere e.g. the National FCERM Strategy.

¹⁵⁴ HM Treasury (2017) *Autumn Budget 2017*.

¹⁵⁵ These numbers represent 7 and 11% of 5 (years) x 300,000 (new homes per year). Note: these calculations do not extrapolate the current (persistent) trend in the percentage of properties built in Flood Zone 3; it merely continues the range identified over 4 years into the future.

Conclusion

Plans are in place through the National Planning Policy Framework to restrict development in areas of significant river or coastal flood risk. A relatively small number of properties are built each year in areas of significant flood risk without protection. A much higher number of properties have been built in at-risk areas with flood protection, which may only increase present day flood risk marginally, but will have more significant longer term consequences as climatic and compounding factors, such as population, change. The impact assessment of different levels of climate change on development needs to have a consistent approach nationwide.

3.2.4 Surface water flood alleviation

What is the risk?

Research for CCRA2¹⁵⁶ showed that the number of people in England exposed to a 1:75 year, or 1.33% annual probability, surface water flood risk could increase from around 680,000 in the present to up to 2,700,000 in the 2080s.

This highest estimate for the 2080s is a result of a 4°C global temperature rise, reduced adaptation interventions and high population growth scenario used in the CCRA2 flooding projections project. The number of people within the 1:75 year risk band could be kept to 1,200,000 in a 2°C world where the adaptation responses in England are enhanced and population growth is low.

CCC progress score	Reason for progress score
2	Plan score - low: The systems for managing surface water flood risk are fragmented but plans and processes are coming together: all 152 Lead Local Flood Authorities (LLFAs) have now published their strategies; and Defra is implementing a surface water management action plan. Climate change is missing from these plans, however, and explicit consideration of 2°C and 4°C global temperature scenarios, as well as further clarification of responsibilities and improvement of delivery mechanisms, would have benefits. Risk score - medium: Water companies are investing in retrofitting sustainable drainage systems (SuDS) in existing homes. However, limited capacity in the sewer network means that the significant increase in surface water flood risk that is projected in CCRA2 is unlikely to be managed adequately on the basis of current action.

¹⁵⁶ Sayers et al. (2015) *Climate Change Risk Assessment 2017: Projections of future flood risk in the UK*.

Is there a good quality plan?

Are plans covered in NAP2?

NAP2 includes no plans (or actions) that, if implemented, would manage the risks from climate change.

The only relevant NAP2 action – ‘Delivery of the recently published surface water management action plan. Progress on implementation of this plan will be monitored by the Inter Ministerial Group on flooding’ – points to another plan and another body to assess that plan rather than any actions that directly address risk.¹⁵⁷ As discussed in Section 3.2.1, the Surface Water Management Action Plan focusses on data and work practices and not actions to reduce flood risk or consideration of different climate change scenarios.

Are there other plans not mentioned in NAP2?

Surface water flood alleviation involves a broader range of drivers and actors than river and coastal flood alleviation. Nonetheless, progress is being made. Notably, all lead local flood authorities (LLFAs, either unitary authorities or county councils) have now produced strategies for managing surface water flooding.

The surface water flood risk management community is more fragmented and complicated than the structure for river and coastal flood risk and the case has been made by the CCC^{158,159} and others^{160,161} that simplification and clarification of these roles and responsibilities would have value. Indeed, the Defra action plan¹⁶² tasks the Environment Agency with clarifying all the key players’ (e.g. LLFAs, water companies, Ofwat, Highways England) roles within the new FCERM Strategy. However, the fragmentation is likely to remain an issue because of the complex and cross cutting nature of the problem rather than poor management or planning as a whole or by individual organisations.

Six years on from the first being available, all LLFAs now have surface water flood management strategies published.¹⁶³ This is a useful metric for progress towards management procedures being in place but the quality and consistency of those 152 plans has not yet been assessed. This is an exercise that should be undertaken by Defra. The registers of local flood risk management assets kept by LLFAs should also be checked in terms of the ownership, maintenance and performance of those assets.¹⁶⁴

Do the plans address the risks in CCRA2?

CCRA2 highlights that the limited capacity in the sewer network is acting as a barrier to managing the projected increase in surface water flooding.

This barrier is not addressed in any of the plans discussed here, though there are actions taking place (see below).

¹⁵⁷ Many of the actions in the Surface Water Management Action Plan are likely to improve working processes and data availability but they will not reduce the flood risk.

¹⁵⁸ CCC (2017) *Progress in preparing for climate change – 2017 Report to Parliament*.

¹⁵⁹ CCC (2019) *UK housing: Fit for the future?*

¹⁶⁰ Water UK (2018) *21st Century Drainage Programme – the context*.

¹⁶¹ Defra (2018) *Review of local approaches to surface water flood risk management*.

¹⁶² Defra (2018) *Surface Water Management – An Action Plan*.

¹⁶³ Environment Agency (2019) *Managing flood and coastal erosion risks in England: 1 April 2017 to 31 March 2018*.

¹⁶⁴ JBA (2018) *Research to define metrics for surface water flood risk management*.

Is progress being made in managing risk?

Are relevant actions taking place?

Whilst progress is being made to ensure that surface water flood managers have the structures and data in place to manage present day flood risk, much less is being done to address the projected increases in surface water flood risk brought about by climate change.

Defra's Action Plan identifies and begins to address important issues with the present structures of surface water flood risk management, particularly in terms of communicating risk and improving risk mapping. This is a necessary initial step to tackle present day risk. Further work is required to develop a strategy to bring these risk levels down and to incorporate future changes to the risk profile.

The data linked with the Environment Agency's 6-year FCERM programme (see Section 3.2.1) show that only 36 of the 500 flood risk alleviation schemes that are under construction or proposed identify surface water flooding as their focus.¹⁶⁵ These 36 schemes would protect 1,820 homes at a combined cost of £5.2 million to the Government's flood defence grant scheme with a further £8 million being required from external contributors as calculated via the partnership funding formula.¹⁶⁶ Given the importance of surface water flood risk, this appears to be a very high financial barrier in terms of the required partnership funding contributions.

Water companies are investing in the retrofitting of sustainable drainage systems (SuDS), as well as other sewerage network resilience measures, in order to reduce the burden on the drainage network and decrease flood risk.

Between 2014 and 2020, water companies will invest £6 billion in making the sewerage network more resilient.¹⁶⁷ Some proportion of this budget has been allocated to the implementation of SuDS measures. Data on the improvements to flood risk should be made available so that the impact can be assessed.

Is there evidence that risk is being managed?

The capacity constraint of England's sewers remains a considerable concern, as does the calculation of the number of properties at risk from surface water flooding in both the present day and in the future.

There has been no new evidence since our previous assessments in 2015¹⁶⁸ and 2017¹⁶⁹ to suggest the capacity problem in the sewer network has been addressed. Analysis from a Water UK report¹⁷⁰ published as part of their 21st Century Drainage Programme shows that there are many areas with a high risk of capacity constraints.

¹⁶⁵ These were identified from the scheme titles. There may be more schemes addressing surface water flooding where they do not make this clear in the title.

¹⁶⁶ Since 2011, proposals for flood defence measures are not assessed on a pass/fail basis but are allocated a certain level of government funding based on the proposal's performance against certain outcome measures. Some proposals may receive full funding but the majority require external contributions in order to go ahead, see Defra (2011) *Flood and Coastal Resilience Partnership Funding*.

¹⁶⁷ Water UK (2018) *21st Century Drainage Programme – the context*.

¹⁶⁸ CCC (2015) *Progress in preparing for climate change – 2015 Report to Parliament*.

¹⁶⁹ CCC (2017) *Progress in preparing for climate change – 2017 Report to Parliament*.

¹⁷⁰ 'First National Pictures of present day available drainage capacity' from Water UK (2018) *Assessing the Available Capacity in UK Sewerage Systems*.

The Water UK report points to population growth, urban creep, infrastructure deterioration and climate change as factors that will further stress the system, and that needs more examination within the 21st Century Drainage research programme. This must also inform the introduction of Drainage and Wastewater Management Plans.¹⁷¹

In July 2018, Defra reported that around 3,200,000 properties are at some risk from surface water flooding in England.¹⁷² However, this indicator has fluctuated over the preceding 6 years, largely because flood risk mapping and assessment techniques have improved.¹⁷³ Whilst this improvement in data is very welcome, quantitative assessments of progress in managing vulnerability and exposure have not been possible to date. There are limitations to the methods required to understand future changes in the frequency, intensity and spatial distribution of the severe storms that often drive surface water flooding.¹⁷⁴ The upcoming release of the high-resolution (2.2 km) data as part of the latest update to the UK Climate Projections¹⁷⁵ (UKCP18) should enable improvements to research in this area. Looking to wider data issues, research for the CCC¹⁷⁶ recommended that information on current risk requires improvement alongside improved future risk maps (e.g. surface water flood zones) and better data on asset management and standards – these datasets would significantly improve our ability to assess vulnerability changes. There are also issues with collecting information on surface water incidents¹⁷⁷ that further complicate the assessment of progress.

Conclusion

Plans are still taking shape to manage the current and future risks from surface water flooding. There is a lack of plans that specifically consider future climate change, or address the capacity limits in the drainage system in England, though investment to improve drainage is being made by water companies. It is currently not possible to assess how risk is changing due to a lack of data.

¹⁷¹ Water UK (2018) *A framework for the production of Drainage and Wastewater Management Plans*.

¹⁷² Defra (2018) *Surface Water Management – An Action Plan*.

¹⁷³ The Environment Agency's Section 18 reports have reported the number of properties at risk of surface water flooding as: 3,800,000 in 2012/13; 3,000,000 in 2013/14; 3,200,000 in 2015/16; and back to 3,000,000 in 2016/17.

¹⁷⁴ Kendon et al. (2017) Do convection-permitting regional climate models improve projections of future precipitation change?, *Bulletin of the American Meteorological Society*, 98, 79-93.

¹⁷⁵ <https://www.metoffice.gov.uk/research/collaboration/ukcp>

¹⁷⁶ JBA (2018) *Research to define metrics for surface water flood risk management*.

¹⁷⁷ Ibid.

3.2.5 Development and surface water flood risk

What is the risk?

Research for CCRA2¹⁷⁸ showed that the number of residential properties in England exposed to a 1:75 year, or 1.33% annual probability, surface water flood risk could increase from around 290,000 in the present to up to as high as 1,100,000 in the 2080s.

This highest estimate for the 2080s is a result of a 4°C global temperature rise, reduced adaptation interventions and high population growth scenario used in the CCRA2 flooding projections project. The number of homes exposed could be kept to 500,000 people in a 2°C world where the adaptation responses in England are enhanced and population growth is low.

CCC progress score	Reason for progress score
1	Plan score - low: There are no plans or processes that ensure new development in areas of surface water flood risk does not increase overall exposure or vulnerability. Some progress has been made since 2017 (e.g. stronger wording in the National Planning Policy Framework) but there is no evidence available on whether this has had an impact on green SuDS uptake in new developments. Risk score - low: As set out in our previous progress report and our 2019 Housing Report, the potential impact of surface water flood risk in new developments could be managed with the wider deployment of 'green' sustainable drainage systems (SuDS) in new developments but there is little evidence that this is happening: there are very few data with which to assess the quantity and quality of SuDS currently being installed in new developments; and there is some evidence that practitioners have little confidence that high quality (green) SuDS are being installed in the majority of developments.

Is there a good quality plan?

Are plans covered in NAP2?

In addition to the action to implement the surface water management action plan discussed in Section 3.2.4, NAP2 also states that the Government will '...ensure that national planning policy [is] effective in managing the risks and impacts of flooding and coastal erosion.'

As with previous NAP2 plans and actions discussed in this report, this plan requires more detail regarding what specifically will be done to achieve this aim.

¹⁷⁸ Sayers et al. (2015) *Climate Change Risk Assessment 2017: Projections of future flood risk in the UK*.

Are there other plans not mentioned in NAP2?

There remains no statutory consultee for assessing new development in areas of surface water flood risk. Improvements to the latest National Planning Policy Framework (NPPF) have strengthened language around avoiding development in high-risk areas, but it is not known how far the NPPF is being implemented. Preference is still not being given to 'green' sustainable drainage systems¹⁷⁹ (SuDS), which could relieve pressure on the drainage system and deliver many co-benefits.

Unlike planning applications in areas of river and coastal flood risk, there is no statutory consultee for developments above certain risk thresholds for surface water flooding. However, all major developments (10 or more properties) that identify surface water flood risk are examined by the lead local flood authority (LLFA). Furthermore, progress has been made with the updated NPPF¹⁸⁰ in terms of managing increases in risk from development (see below) but, as national data are not compiled on the number of planning applications made in areas of surface water flood risk, nor the impact of the advice that is subsequently given, the effectiveness of the NPPF update cannot be assessed. The collection of these data should be required as it is crucial to develop an adequate plan to manage surface water flood risk.

For actions to tackle vulnerability, the updated NPPF included stronger wording in relation to sustainable drainage. In the original NPPF¹⁸¹, SuDS were to be considered as 'a priority' for developments in areas of flood risk and/or where critical drainage problems exist. The updated version states that SuDS should be incorporated 'unless there is clear evidence that this would be inappropriate' in areas of flood risk/drainage issues¹⁸² as well as more generally.¹⁸³

It is also stated that the SuDS should 'where possible, provide multifunctional benefits'¹⁸⁴ and should 'have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development'.¹⁸⁵ Ideally, tackling these issues of 'grey vs green' SuDS and their adoption would be dealt with more explicitly in updated planning practice guidance but the NPPF changes are a step in the right direction. Moreover, the updated planning practice guidance on multi-use SuDS represents an opportunity for developers to address other aspects of planning related to green infrastructure efficiently, rather than viewing it as an onerous SuDS condition. Measure 2.2.2 of the draft updated FCERM Strategy (see Box 3.1) would formalise this approach. Overall, whilst the 2019 updates to the NPPF represent progress, it would be preferable to commence Schedule 3 of the Flood and Water Management Act (2010), which sets out SuDS standards, an approval process, rules on adoption and changes to the right to connect to public sewers.

Local planning authorities should only allow major development in areas subject to surface water flooding if the development is safe and does not increase the risk elsewhere. However, the standards defining how to discharge this duty in practice are non-statutory and monitoring is not undertaken for either major or non-major developments.

¹⁷⁹ SuDS can be classified as 'grey' (for example underground pipes or tanks), or 'green' (for example greenspace, swales, green roofs).

¹⁸⁰ MHCLG (2019) *National Planning Policy Framework*.

¹⁸¹ DCLG (2012) *National Planning Policy Framework*.

¹⁸² MHCLG (2019) NPPF paragraph 163c.

¹⁸³ MHCLG (2019) NPPF paragraph 165.

¹⁸⁴ MHCLG (2019) NPPF paragraph 165d.

¹⁸⁵ MHCLG (2019) NPPF paragraph 165c.

While major developments are reviewed by the LLFA, non-major developments (developments of fewer than 10 properties) are not routinely examined by the LLFA. The CCC has previously commissioned an investigation into these non-major developments with regard to their impact on flood risk and did not uncover any significant problems.¹⁸⁶ Nonetheless, there is potential for poor choices to be made regarding development in such cases, particularly as there are no data available on the number of properties that fall into this category. Either the consultation process requires improvement or there needs to be routine monitoring of the decisions that are made to ensure that these developments are not adversely affecting overall flood risk.

Data on the number of planning applications for any size of development that is at risk of surface water flooding are not collected nationally by Defra or the Ministry for Housing, Communities and Local Government (MHCLG). This means that it is not possible to assess the increase in exposure to surface water flood risk from new developments or how often advice on mitigating surface water flood risk for new developments is not followed.

Do the plans address the risks in CCRA2?

The plans do not directly respond to the risks outlined in CCRA2.

The policy response is insufficient to manage the magnitude of current and future exposure, and the deployment of the key response – SuDS – is not integrated into plans in a rigorous way.

Is progress being made in managing risk?

Are relevant actions taking place?

While guidance around planning related to SuDS has improved, there remains no monitoring of how many new properties are being built in areas at surface water flood risk or how many properties benefit from SuDS, so progress still cannot be measured.

There is some evidence that SuDS are being installed more widely in new developments in England¹⁸⁷, but it is unclear whether 'green' SuDS with multiple benefits are being deployed in preference to 'grey' SuDS.¹⁸⁸ New developments are adding pressure to existing, strained drainage networks. A survey by CIWEM found that practitioners had little confidence that green SuDS are being built in the majority of major new developments.¹⁸⁹ The CCC housing report identified significant barriers to the implementation of green SuDS, including: different national and local organisational structures; the non-statutory Technical Standards for SuDS only apply to developments of 10 or more houses and do not promote green SuDS; and the lack of clear guidance on responsibilities for adoption and maintenance. These factors all require urgent attention. A metric of the overall impact on surface water flooding risk of the SuDS being installed needs to be developed and recorded so that changes in vulnerability can be assessed.

¹⁸⁶ HR Wallingford (2012) *Development of spatial indicators to monitor changes in exposure and vulnerability to flooding and the uptake of adaptation actions to manage flood risk in England: Results Report*.

¹⁸⁷ The 2018 MHCLG review found that 87% of a sample of approved planning applications in England explicitly featured SuDS.

¹⁸⁸ CCC (2019) *UK housing: fit for the future?*

¹⁸⁹ CIWEM's 2016 'A place for SuDS?' report found that around 30% of the 500 respondents said that SuDS (of any type) are not used in all major developments, as current guidance requires, and a further 28% did not know whether this was the case. In many cases the SuDS being built were below-ground retention systems.

As with river and coastal flooding, new homes built after 1 January 2009 are excluded from the re-insurance scheme Flood Re, which should act as an incentive to ensure new development is located away from flood risk areas, incorporates SuDS and/or includes flood resilience measures (see Section 3.2.5), but it is not known whether this is the case.

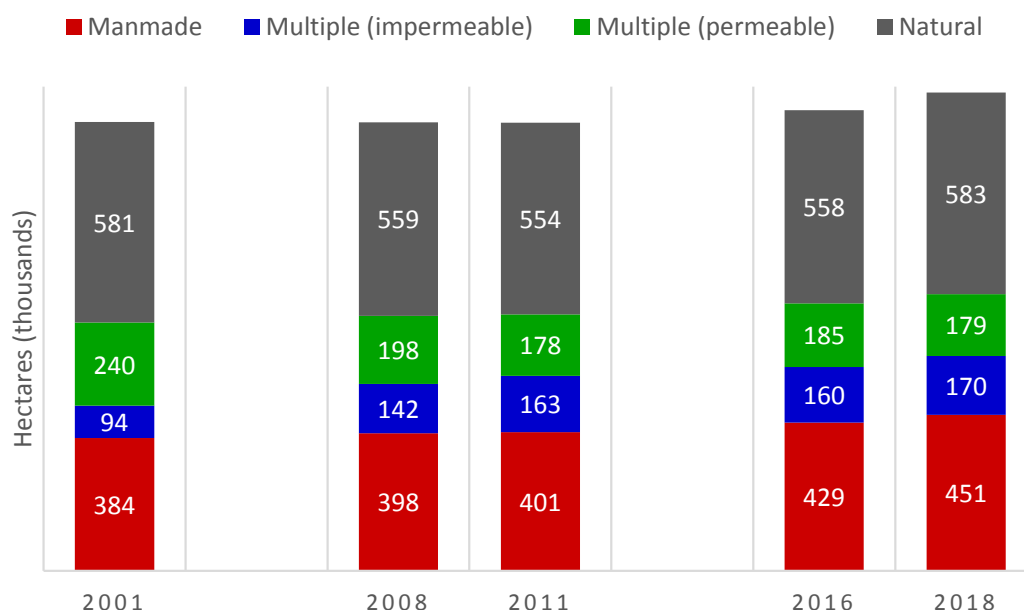
The total area of impermeable surfaces in urban locations has increased by 30% between 2001 and 2018 (Figure 3.4). As a proportion of total urban area, which has itself increased, this equates to a 22% increase in impermeable surfaces between 2001 and 2018.

This increase is made up of a rise in manmade surfaces (17% total or 10% proportional increase from 384,000 hectares in 2001 to 451,000 hectares in 2018) and multiple surfaces that are impermeable, such as partially paved domestic gardens and road verges, for example (82% total or 70% proportional increase from 94,000 hectares in 2001 to 170,000 hectares in 2018). These trends increase stress on the sewer system by increasing surface water run-off in urban areas.

Some of this increase may have been driven by permitted development rights. These rights allow people to build extensions and other buildings, such as sheds and garages, on their property without permission if the building work meets certain criteria.¹⁹⁰ However, given that permission is not required, we have no data on the extent of permitted developments in England.

¹⁹⁰ DCLG (2017) *Permitted development rights for householders - Technical guidance*.

Figure 3.4. Area of permeable and impermeable land within all urban areas in England



Sources: HR Wallingford (2012) *Development of spatial indicators to monitor changes in exposure and vulnerability to flooding and the uptake of adaptation actions to manage flood risk in England*. ADAS (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*.

Notes: The broad categories of land shown are:

- Natural – features that are not man-made but possibly man altered, for example parkland, areas of water and uncultivated/cultivated vegetation.
- Manmade – features that have been constructed, for example, areas of tarmac or concrete including roads, paths and buildings.
- Multiple – features that contain a mixture of surfaces but are not depicted separately within the data, for example, residential gardens and road verges.

For the purposes of this study, it was assumed that 'natural' surfaces are permeable and 'man-made' are impermeable. These were measured directly via analysis of the MasterMap Topography Layer. The permeable area of the multiple category was more difficult to determine quantitatively since the MasterMap data does not sub-categorise the proportion which is paved. There is a considerable amount of variation in the proportion of impermeable surfaces within the multiple category, ranging from approximately 90% in densely urban areas to 40% in the suburbs. A method was developed that estimated the impermeable fraction of multiple land for low, medium and high density development and the rate of change of permeability ('urban creep') in this fraction, based on the results of a number of studies in different parts of the country that have used aerial photography and site surveys. The data available does not allow us to assess the potential uptake of permeable surfacing measures. As such, a proportion of the observed increase in hard surfacing in the man-made and multiple land categories will have been permeable. However, an HR Wallingford survey of paving manufacturers suggests this is likely to be low.

Is there evidence that risk is being managed?

As described above, there are only data or evidence showing increased risk.

The data that could show that the planning system is reducing risk are not collected and there are no other indications that such a reduction is happening.

Conclusion

There is still no evidence that new developments are installing green SuDS as a preference over grey SuDS, as is now more strongly encouraged in the National Planning Policy Framework. There is also a lack of evidence to show that the increase in risk in new developments from surface water flooding due to climate change is being managed. The only evidence available, on the proportion of urban areas made up of impermeable surfacing, shows that vulnerability is increasing.

3.2.6 Property-level flood resilience (PFR)

What is the risk?

There is concern in CCRA2 that the implementation of PFR measures is too slow to capitalise on the potential to reduce vulnerability to flooding.

PFR is an efficient route to avoiding or minimising damages from flooding when exposure already exists, or is inevitable with new developments. However, the drive towards widespread PFR implementation has not yet started.

CCC progress score	Reason for progress score
3	Plan score - medium: Important aspirations have been outlined by Defra in the Property Flood Resilience Action Plan and work continues towards a Code of Practice and Certification Scheme. Flood Re are developing approaches to encourage homeowners to put property-level flood resilience (PFR) measures in place. However, the Environment Agency's analysis of PFR cost-effectiveness needs to be translated into clear targets or approaches for large-scale implementation of PFR measures. PFR plans do not consider the design and number of PFR interventions required in the context of climate changes of any magnitude. Risk score - low: PFR measures are being implemented, but the current rate of PFR implementation is a long way below the optimum identified in the Environment Agency's latest flood risk investment analysis.

Is there a good quality plan?

Are plans covered in NAP2?

The relevant NAP2 action proposes to: 'Continue to support the industry-led Property Flood Resilience Roundtable, including supporting an industry-owned voluntary code of practice to promote consumer and business confidence in measures to reduce the impact of flooding on buildings, and on those who live and work in them'.

The wider NAP2 plan is to promote PFR and to work on removing the remaining barriers to PFR becoming normal practice. NAP2 cites Defra's Property Flood Resilience Action Plan¹⁹¹ as the mechanism to deliver this. However, NAP2 and the action plan do not set out any specific ambition for the role of PFR in managing vulnerability or propose a strategy to drive the large-scale implementation of PFR.

Are there other plans not mentioned in NAP2?

The targets outlined by Defra in the action plan in relation to PFR are phrased in terms of individuals' and businesses' perception of PFR rather than the number and locations of properties that should be made resilient – this should be changed as much progress is needed to maximise the benefits of PFR.

The Property Flood Resilience Action Plan includes the vision to achieve, within five years, an 'environment where it is standard practice for properties at high flood risk to be made resilient' and, within 2 years to have made 'significant progress towards developing the systems and practices within the insurance, building and finance sectors that normalise the uptake of property level resilience within existing activity'. These are valuable aspirations in the context of climate change, and are supported by the NAP2 action in relation to the PFR Roundtable (see above), but do not quantify the number of properties or prioritise locations where PFR would have value. Progress towards these aspirations has not been tracked.

The revised National Planning Policy Framework (NPPF) states that developments in areas of flood risk should be supported by 'site-specific flood-risk assessment' and should be made 'appropriately flood resistant and resilient'¹⁹², which is positive, but requires a system to monitor progress.

Flood Re launched in April 2016 and now underwrites over 150,000 policies.¹⁹³

Flood Re provides reinsurance to insurance companies for high flood-risk properties built before 2009. The properties covered by Flood Re which are then flooded are also likely to be the same as those that could benefit most from PFR, given that flood defences alone are not protecting them completely. However, there are no targets in NAP2 regarding the steps that need to be taken for Flood Re's withdrawal in 2039 or regarding Flood Re's potential role in incentivising PFR measures for properties at particular risk. Independent of NAP2, Flood Re is developing a plan to promote PFR¹⁹⁴, which has the potential to reduce vulnerability. There is a conflict of approaches to be resolved in that a subsidised insurance scheme largely removes the financial incentive for high risk households themselves to take action to prevent flooding losses via PFR.

Do the plans address the risks in CCRA2?

An appropriate target for PFR installations could be calculated from LTIS2 or CCRA2 but this has not been done in NAP2 or elsewhere.

Therefore, the plans do not address the necessary response to flood risk as outlined in CCRA2.

¹⁹¹ Defra (2016) *The Property Flood Resilience Action Plan*.

¹⁹² MHCLG (2019) NPPF paragraph 163.

¹⁹³ Flood Re (2018) *Annual Report*.

¹⁹⁴ Flood Re (2018) *Incentivising household action on flooding and options for using incentives to increase the take up of flood resilience and resistance measures*.

Is progress being made in managing risk?

Are relevant actions taking place?

At least 1,245 homes have implemented PFR measures since April 2015, which is a rate of at least 415 properties per year.¹⁹⁵

This is below the anticipated 500 households per year that was proposed in the Government's six-year FCERM investment programme. However, it is difficult to get an accurate number of installations because: a) centrally funded schemes don't necessarily report how many properties are adapted; b) recovery grants issued following flood events may or may not be used for PFR; and c) individuals may install PFR measures independently of any Government funding scheme. Given that over 11,000 recovery grants (see Section 3.2.7) were approved in 2015/16 alone¹⁹⁶, it is likely that more than 1,245 properties had PFR measures installed since April 2015. This highlights the need for better data collection in this area.

Is there evidence that risk is being managed?

Despite the data problem, the rate of property-level flood resilience (PFR) installation is almost certainly well below the optimum.

The analysis from the Environment Agency's 2019 Long Term Investment Scenarios¹⁹⁷ (LTIS2) indicates that there are approximately 226,000 homes in England that would benefit from PFR. Ideally, these properties would have this protection implemented as soon as possible in order to maximise the benefits. However, the withdrawal of Flood Re in 2039, which should complete the transition to risk-reflective insurance pricing in the UK, represents a more realistic deadline to have completed these installations. To achieve this would require a steady rate of over 9,000 properties having PFR installed every year up to 2039, although earlier installation would bring extra benefits. The current rate is closer to 500 properties per year, and appears to be falling in the short-term.¹⁹⁸ There is a significant gap that needs to be addressed.

There are barriers to the implementation of PFR that need to be addressed urgently.

For example, many insurers do not allow improvements in terms of PFR to be made when flooded properties are reinstated with the insurance pay-out.¹⁹⁹ Insurance brokers do not generally have a positive view of PFR.²⁰⁰ These points are appreciated within the draft, updated FCERM Strategy and Measure 2.4.1, which aims to facilitate a system where it is more common to 'build back better and in better places', addresses these issues. The CCC's 2019 housing report²⁰¹ identified and discussed other barriers to PFR, namely: lack of motivation from householders; lack of familiarity and access to information; costs and behavioural biases to taking action; and lack of professional skills and knowledge. These issues need to be addressed,

¹⁹⁵ ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*.

¹⁹⁶ Coffey, T. (2018) Response to Written question 172487, 13 September 2018
<https://www.parliament.uk/business/publications/written-questions-answers-statements/written-question/Commons/2018-09-10/172487/>

¹⁹⁷ Environment Agency (2019) *Long Term Investment Scenarios*.

¹⁹⁸ ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*.

¹⁹⁹ Defra (2016) *The property flood resilience action plan*.

²⁰⁰ For example, over 50% of brokers surveyed thought that door and window shields, non-return sewer valves or air brick covers either had no effect whatsoever or were not very effective. These data were taken from Defra (2016) *The Property Flood Resilience Action Plan*.

²⁰¹ CCC (2019) *UK housing: fit for the future?*

which could be achieved partially via a Certification Scheme and a new Code of Practice for PFR. These are due to be introduced in 2019.²⁰² The Code should ensure better installation, enforcement and compliance in relation to PFR measures.

Defra has also committed in NAP2 to support the industry-led Property Flood Resilience Roundtable, which is developing the industry-owned, voluntary Code of Practice to promote consumer and business confidence in measures to reduce the impact of flooding on buildings, and on those who live and work in them.²⁰³

Conclusion

The scale of the required actions to promote the uptake of PFR have been set out in various analyses (e.g. LTIS2) but there are no plans that identify how to achieve those levels of deployment. Actual progress is a long way short of that required to adapt to even a 2°C global temperature scenario.

3.2.7 Capacity of people and communities to recover from flooding

What is the risk?

Flooding can have significant economic consequences for communities and mental and physical health impacts on individuals.

Decreasing the recovery time following a flood will reduce the impacts of an event, and can increase resilience to future events.

CCC progress score	Reason for progress score
5	Plan score - medium: Local resilience forums have developed response and recovery plans for flooding based on present-day risk. There needs to be evidence that organisations involved in flood recovery are starting to consider how the risk from flooding might be changing due to climate change. Risk score - medium: Repair and renew grants are available from MHCLG for selected flood events. In severe flood events, insurance claims can take up to a year to settle, which has a significant impact on recovery time and the well-being of those affected. There is evidence that Flood Re has improved access to affordable insurance for properties where flood related insurance claims have been made previously. More data collection is needed to understand rates of recovery.

²⁰² Defra (2018) *The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting*.

²⁰³ Defra (2017) *Defra Property Level Flood Resilience Roundtable 2017 End-Of-Year 1 Report*.

Is there a good quality plan?

Are plans covered in NAP2?

NAP2 aims to improve the recovery time following a flood but outlines no actions that would deliver this.

The discussion around recovery focusses on property-level resilience measures but, as discussed in Section 3.2.6 above, this is not well-covered in NAP2 either. The 25 Year Environment Plan states that recovery time should be accelerated, but does not identify how to achieve this.

Are there other plans not mentioned in NAP2?

There is no single plan or information source to guide people, communities and businesses during their recovery from flooding. Whilst there are many organisations that are managing different parts of the system, further integration of plans could reduce the time taken for people to return to their properties following a flood and to avoid the worst impacts of flood events.

Recovery from flooding events is a function of many complex and interacting factors, including: being well protected where appropriate (Sections 3.2.1 and 3.2.3); receiving adequate warnings of imminent flooding and being prepared to respond; the effectiveness of the immediate emergency response (Section 3.6); having flood resilience measures in place to minimise the impact (Section 3.2.5); having financial assistance, through insurance and grants, to repair and renew property (Sections 3.2.1 to 3.2.4); having access to social support networks; the availability of builders and other actors in the recovery process; and the medium- and long-term strategies to return people to their homes and to manage the physical and mental health impacts (Section 3.6). There are many different teams and organisations involved in this process and increased integration or collaboration between those organisations would be likely to increase the speed with which flood victims can recover.

The Civil Contingencies Secretariat outlines plans at the national level for dealing with flood-related emergencies in the National Risk Assessment (NRA) (see Section 3.6). Departments are routinely asked for updates to the NRA, but it is not known whether consideration is yet being given to whether climate change is beginning to change the risk profile for major flood events. Local Resilience Forums (LRFs) provide information on what to do before, during and after a flood – this will be aligned with their emergency plans²⁰⁴, which should be developed to manage people's physical and psychological recovery from flood events. Other bodies (e.g. Environment Agency, National Flood Forum, local councils, utility companies, Highways England) also provide advice on how to prepare and recover from flooding events. Public Health England provides advice on how to clean up safely following a flood and gives advice on flooding and mental health.²⁰⁵ This latter aspect is an important element of the problem and research is ongoing to understand how best to support people through these issues.²⁰⁶

Recovery and returning home can be a slow process, sometimes taking over a year (see Figure 3.7 below). The time taken depends on many factors, including the depth of the flood water (Figure 3.5) as well as the duration of the flood, how contaminated the flood water was, the length of time it takes to dry out a property (influenced by the building materials, time of year

²⁰⁴ Cabinet Office (2013) *Emergency Response and Recovery- Non statutory guidance accompanying the Civil Contingencies Act 2004*.

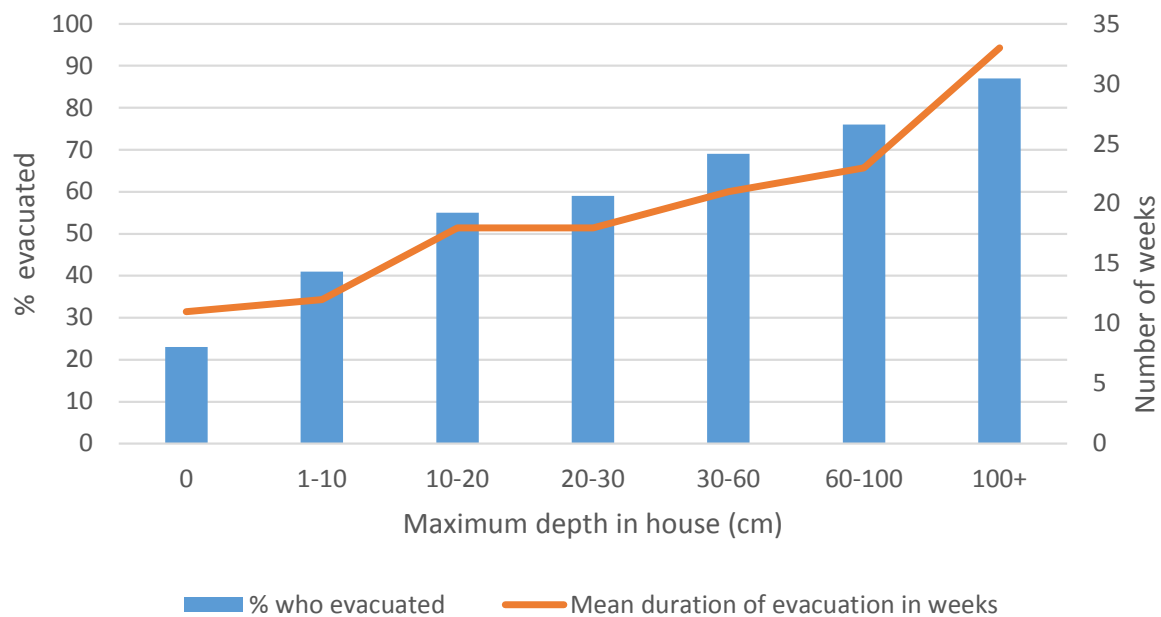
²⁰⁵ PHE (2014) *Floods – how to clean up your home safely*.

²⁰⁶ PHE (2017) *The English National Study for Flooding and Health: First year report*.

and weather), waiting for the insurance payments, and/or the availability of builders and materials to undertake the repairs, which can be especially stretched after major events. With such a variable and diverse range of drivers, and much depending on the characteristics of the property, it may be counterproductive to set targets to get people back into their homes.

However, it is important to monitor how long it takes and to identify the factors that cause the longest delays, so that future efforts to reduce recovery times can be implemented efficiently.

Figure 3.5. Relationship between flood depth and length of evacuation



Source: ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England* using data from Penning-Roswell et al. (2013) *Flood and Coastal Erosion Risk Management: A Manual for Economic Appraisal*.

Do the plans address the risks in CCRA2?

Plans are in place to help people recover from flood events.

Capacity may be stretched in the future with a potential increase in frequency and severity of flooding. This needs to be accounted for as plans develop.

Is progress being made in managing risk?

Are relevant actions taking place?

Flood recovery grants are often made available following major flood events (e.g. 2013/14 winter flooding events, Storms Desmond and Eva in 2015/16). There are no plans in NAP2 to formalise or extend these grant schemes.

However, the decision making process on whether to initiate such schemes is currently subjective: it is based on whether 'Ministers determine central recovery support is

appropriate’.²⁰⁷ This scheme has awarded grants of up to £500 to homeowners and £2,500 to businesses to aid recovery. This MHCLG scheme has also been supplemented by a Property Level Recovery scheme from Defra where grants of up to £5,000 have been distributed to improve the resilience of properties during repair. These schemes provide much needed support for those that experience flood damage but a more formalised system with clear outcomes is required if it is to be used to manage vulnerability to climate change effectively and proactively.

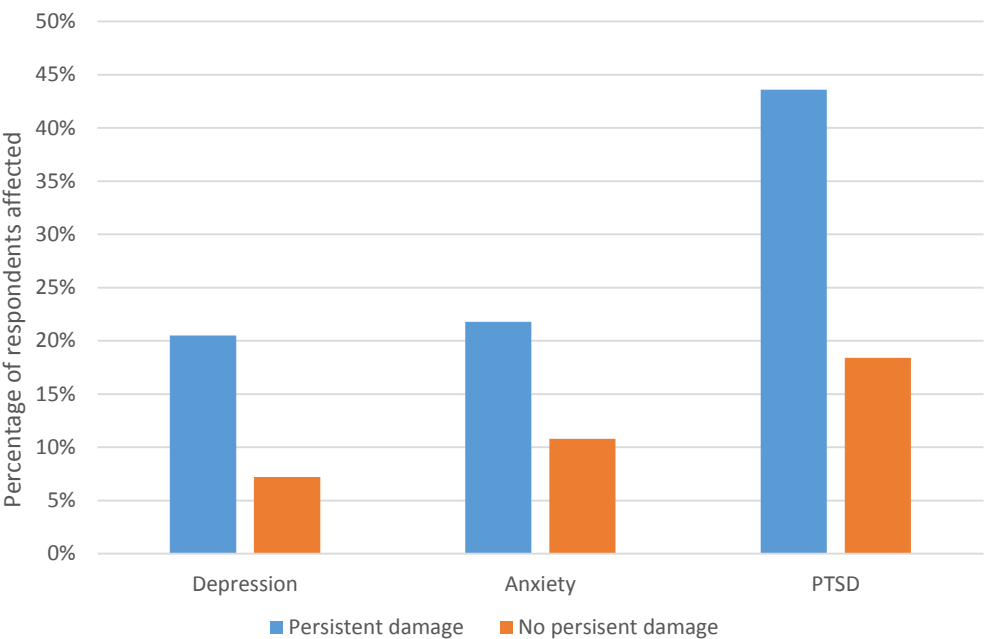
To ensure value for money, there should be close collaboration between the local authorities issuing the grants and the insurers leading the recovery, ideally with efficient auditing in place.

Is there evidence that risk is being managed?

People need to return to their homes as quickly as it is safe to do so following flood events and the impacts on physical and mental health need to be minimised. At present, we do not have data to assess any trends in these factors but work is ongoing to understand these issues in more depth.

This is an important issue: there is good evidence that people who are impacted by flooding events are more likely to experience poor mental health in the aftermath (Figure 3.6). Any progress made in this area has the potential to deliver significant benefits to flood victims and reduce costs across Government departments.

Figure 3.6. Mental health impacts from flooding



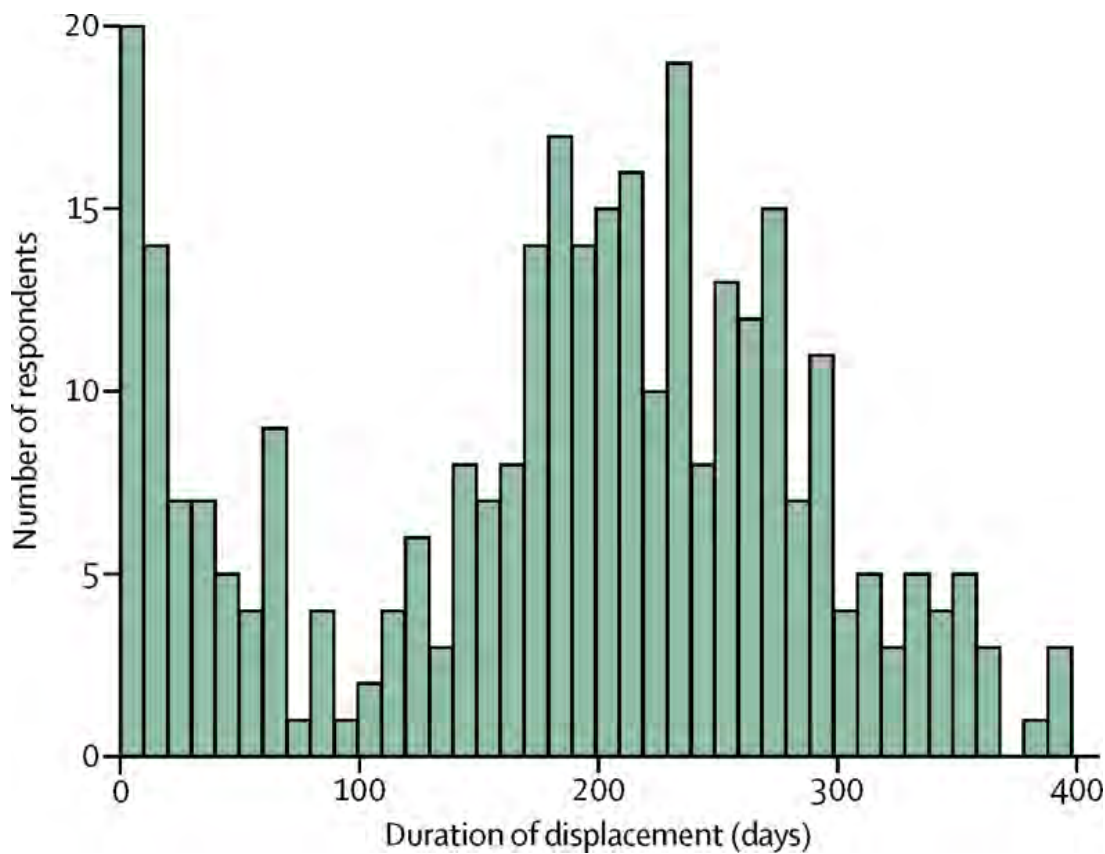
Source: ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England* using data from Jermacane et al. (2017) *The English National Cohort Study of Flooding and Health: the change in the prevalence of psychological morbidity at year two*, *BMC Public Health*, 18, 330.

Notes: The data show the prevalence of mental health outcomes (post-traumatic stress disorder, anxiety and depression) two years following the flood event for participants who experienced persistent damage or no persistent damage.

²⁰⁷ DCLG (2017) *Flood recovery framework: guidance for local authorities in England*.

A Public Health England study²⁰⁸ that examined the duration of displacement of those affected by the 2013/14 winter floods in Gloucestershire, Wiltshire, Surrey, Somerset and Kent found that most people returned to their homes between 6 and 12 months after evacuating, though around 10 households were still not back in their homes after one year (Figure 3.7). These data give an indication of the scale of the problem but, as discussed above, this monitoring is not routine or formalised (particularly in terms of contextual hazard data, such as depth and duration of flood) so we cannot assess the differences between different flood events over time and whether recovery times are getting better or worse. Considering the factors that determine recovery time, there are data to show that the settlement of insurance claims followed a similar pattern to Figure 3.7, with 60% of claims from the 2013/14 flood being fully settled within 6 months and nearly all completed within a year²⁰⁹, but it is not clear whether this was a correlation or shows a causal relationship.

Figure 3.7. Duration of displacement post-flood



Source: Munro et al. (2017) Effect of evacuation and displacement on the association between flooding and mental health outcomes: a cross-sectional analysis of UK survey data, *Lancet Planet Health*, 1, 134-141.
Notes: The duration of displacement (in days) for those who were flooded and displaced within the Public Health England study into the mental health impacts of flooding.

²⁰⁸ Munro et al. (2017) Effect of evacuation and displacement on the association between flooding and mental health outcomes: a cross-sectional analysis of UK survey data, *Lancet Planet Health*, 1, 134-141.
²⁰⁹ ABI (2016) *Responding to major floods*.

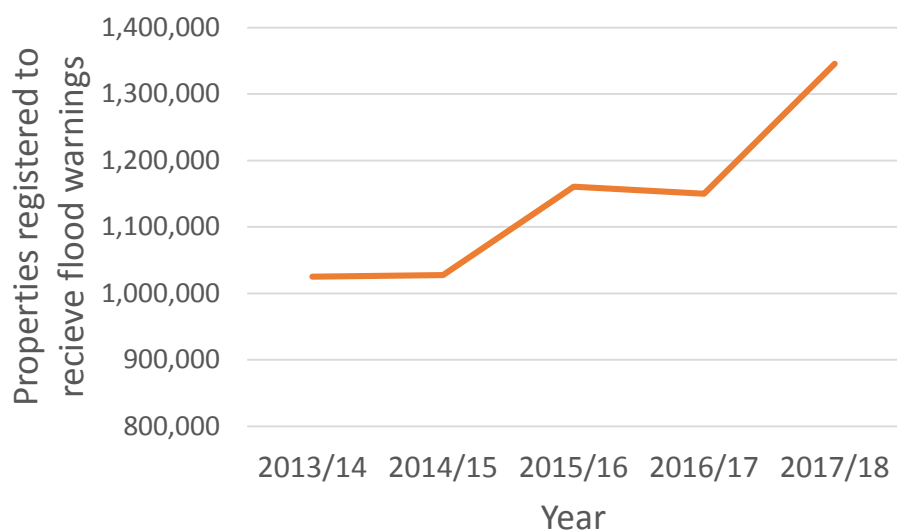
There is evidence that Flood Re has improved the ability of households that have previously been flooded to access affordable insurance.

Before Flood Re was introduced, only nine percent of those households could get two or more quotes for insurance; after the introduction of Flood Re, 100% of those households could get two or more quotes; and 80% of households that had previously made flood claims saw their premium drop by more than 50%.²¹⁰ This is good progress.

The ability to prepare for flooding in terms of keeping safe and minimising damage to property and possessions relies on high quality forecasts, which are received and acted upon.

Annual reports from the Flood Forecast Centre²¹¹ indicate that the probabilities of detection (POD) for surface water flooding and river flooding have been consistent over time and give useful information.²¹² Environment Agency figures show that the rate of people signing up to the flood warning service in England is increasing (Figure 3.8). The draft, updated FCERM Strategy also aims to expand the warning service (Measure 3.3.2) and to improve how people interpret and respond to their flood risk (Measures 3.2.1 and 3.2.2).

Figure 3.8. Flood warning registrations



Source: Environment Agency.

There are no openly available data that allow an assessment of the proportion of homes or businesses that have insurance to cover flood risk.

²¹⁰ Flood Re (2018) *Securing a future of affordable flood insurance*.

²¹¹ <http://www.ffc-environment-agency.metoffice.gov.uk/about/>

²¹² Surface water flooding 2-day lead time POD of 67% for 2017 and 66% for 2018 (based on 36 month period ending March 2017 and March 2018, respectively). River flooding 3-day lead time POD of 53% for 2017 and 51% for 2018 (based on 36 month period ending March 2017 and March 2018, respectively). There are insufficient cases to calculate statistics for coastal or groundwater flooding.

Insurance companies do not openly release details of the properties they cover because they operate in a competitive market. The Government's Household Expenditure Survey²¹³ would not identify leaseholders that will have cover but do not pay for it themselves. Ideally, the number of homes and businesses in high-risk flood areas that have no insurance could be calculated and tracked. There would be significant value in understanding why these homes and businesses are not insured. For example, is insurance unaffordable, is the property uninsurable or is it a personal decision driven by a different reason?

Conclusion

There are plans and actions in place that are working towards reducing the impacts from flood risk, though these do not explicitly consider the potential increase in risk with climate change. Work is still required to understand the scale of this risk, how climate change will alter it, and what the most effective mix of social, economic and technical responses are to manage it in the future.

3.3 Coastal erosion risk management

What is the risk?

CCRA2²¹⁴ and the CCC's report on coastal adaptation²¹⁵ reported that around a third of the English coastline is subject to erosion, which can be exacerbated by heavy or prolonged rainfall, coastal storms or sea-level rise.

Today, this means that around 5,500 residential properties are located in areas at risk of being lost to coastal erosion. By the end of the century, this figure could rise to over 160,000, alongside 43,000 non-residential properties, 150km of major roads and 100km of railway line. There is significant uncertainty in all these numbers as the method for calculating erosion requires improvement to reflect the full range of potential climate change impacts and types of erosion (i.e. the erosion of complex cliffs needs to be included).

²¹³ ONS (2018) *Family spending in the UK: financial year ending 2017*.

²¹⁴ CCC (2016) *UK Climate Change Risk Assessment 2017 Evidence Report*.

²¹⁵ CCC (2018) *Managing the coast in a changing climate*.

CCC progress score	Reason for progress score
3	Plan score - medium: The Shoreline Management Plans (SMPs) set out strategies for England's coasts based on a range of climate scenarios. However, their non-statutory status and incomplete economic grounding limits their use as long-term plans. The translation of the SMPs into a resourced, national strategy for coastal erosion management has not yet happened. Risk score - low: There is no record of properties lost or relocated due to coastal erosion and it is difficult to assess likely future losses with the available projections. It is, therefore, not possible at present to assess progress in managing vulnerability. Further erosion management schemes have been implemented in the last 2 years but there has been inadequate progress in delivering 'managed realignment' schemes relative to the SMP ambitions.

Is there a good quality plan?

Are plans covered in NAP2?

NAP2 proposes a 're-fresh' of the Shoreline Management Plans²¹⁶ (SMPs) with more emphasis on the practical aspects of delivering SMP policies and 'reality checking' the policies.

However, this falls short of a comprehensive and holistic cost-benefit analysis to identify areas that potentially require more drastic adaptations. Further, the policy decisions within the SMPs are non-statutory, have not undergone a thorough economic assessment and are not based on climate change scenario driven projections of future coastal erosion. Despite recent research advances²¹⁷, the capacity and strategies to engage and co-develop adaptation plans with at-risk communities has not yet been mainstreamed into practice. The CCC's coastal analysis²¹⁸ identified that a significant proportion of England's coast (over 25%) is unlikely to receive the funding that is required to implement the SMP policy decisions²¹⁹ and concluded that England's approach to coastal adaptation is 'not fit for purpose'. The draft, updated FCERM Strategy does not take the opportunity to address some of these problems and refers to the 're-fresh' and ongoing review of SMPs (Measure 2.4.2).

Are there other plans not mentioned in NAP2?

Coastal change is also addressed in other plans and strategies that cover FCERM e.g. the Environment Agency's National FCERM Strategy and the 25 Year Environment Plan.

²¹⁶ The Shoreline Management Plans set out the objectives for the long-term management of England's coastline and they are discussed in much greater depth in CCC (2018) *Managing the coast in a changing climate*.

²¹⁷ Nicholls et al. (2015) *Broad Scale Coastal Simulation*. Springer, Netherlands, Dordrecht.

²¹⁸ CCC (2018) *Managing the coast in a changing climate*.

²¹⁹ Analysis of the policy decisions outlined in the SMPs showed that around 25% of the coast would have a cost-to-benefit ratio of less than two. FCERM measures that have received funding in recent years have a cost-to-benefit ratio of around eight.

However, the SMPs are the main focus for adaptation planning for coastal erosion.

Do the plans address the risks in CCRA2?

There are no plans or actions in NAP2 that directly address the risk to the properties and other assets that may be lost to coastal erosion.

The only relevant NAP2 action has no clear outcome related to reducing risk as it points to the re-writing of the non-statutory SMPs.²²⁰ The SMPs themselves have outcomes in the form of policy decisions for each policy unit of the coast but these are not linked to different climate change scenarios. Indeed, the underlying dataset – the National Coastal Erosion Risk Map – is not driven by different climate scenarios so it is not possible to develop those decisions for different climate futures in an evidence-based fashion. As stated above, the SMPs are non-statutory so the policy decision may not be implemented.

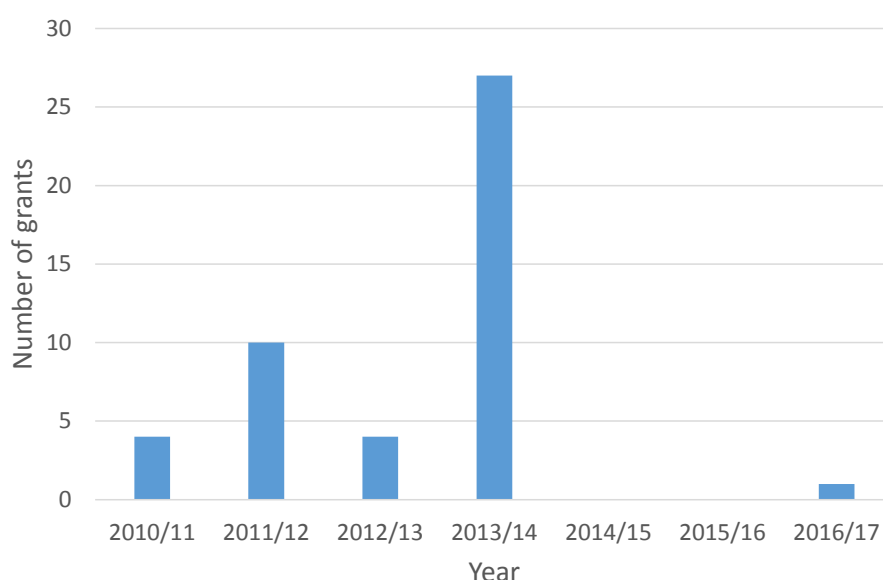
Is progress being made in managing risk?

Are relevant actions taking place?

Since April 2017, 1,492 homes have benefitted from coastal erosion management schemes.

In general, there is no compensation for property losses to erosion and these losses are uninsurable. Where properties are lost, householders may be eligible for a demolition and removal grant of up to £6,000. The distribution of these grants is very variable and there is no trend in the data (Figure 3.9), which could be a feature of the intermittency of coastal erosion events, such as cliff falls, or other factors linked to the administration or awareness of the grant scheme.

Figure 3.9. Grants for demolition and removal due to coastal erosion



Source: Defra (2018) *Managing flood and coastal erosion risks in England*.

²²⁰ NAP action update – appendix A

In 2013, the CCC reported²²¹ that the rate of managed realignment schemes around the coast was around five times slower than required to meet the 2030 aspiration set out in the SMPs – we have been unable to obtain data to update that figure for this report.

The SMPs identified 550 km of the English coastline that should be realigned by 2030. In the 2013 CCC report it was believed that 110 km would be re-aligned by 2016, which is well short of the 30 km per year rate that would be required to meet the 2030 aspiration. Furthermore, it is not known whether these specific 110 km were identified as requiring realignment within the SMPs. The progress of SMP policy decisions should be tracked and reported.

New and existing properties may be at risk because of uncertainty over the progress towards the SMP policy decisions.

Planning for new properties and managing the future of properties at significant risk relies on an assumption that SMP policy decisions are implemented, because the National Planning Policy Framework (NPPF) states that this is the evidence base that local planners should use for their local plans. Where policy decisions are being implemented (these are not tracked), and where local authorities have developed a Coastal Change Management Area (CCMA), the NPPF does indicate that new developments should not go ahead. However, it is unknown how frequently this process is being followed and, therefore, the extent to which planning decisions are increasing exposure.

Is there evidence that risk is being managed?

At present, there is no national dataset of properties lost to coastal erosion nor, as mentioned above, any tracking of SMP policy implementation.

Without these baseline data, it is not possible to assess the change in exposure or the viability of the coastal local plans that use the SMPs as their evidence base.

As outlined in NAP2, it is important that people are able to access data on their exposure to different natural hazards.

Whilst the NCERM data are openly available online, they are not available in an easy-to-use format²²²; Scotland's Dynamic Coast website²²³ shows that this is possible and a similar approach should be adopted in England.

The coastal pathfinder projects²²⁴ developed a small number of sustainable responses to coastal changes but this has not yet developed into an ongoing programme of coastal adaptation.

In particular, further investigation and investment is required for: long-term engagement with coastal communities and businesses; strategies for relocating unsustainable communities; and the methods required for valuing the reinstatement of natural environments and processes.

²²¹ CCC (2013) *Managing the land in a changing climate*.

²²² These data are available as 22 separate GIS files that require specific software, as well as a certain amount of knowledge and time, to access and view.

²²³ <http://www.dynamiccoast.com/>

²²⁴ Defra (2012) *Coastal change pathfinder review*.

Conclusion

The Shoreline Management Plans would, in principle, form a long-term, sustainable plan to address coastal erosion if they were implemented and sufficiently resourced, which is not the case. Even with appropriate committed resource, there are still elements of the plans that fail to accept the full scale of future climate change risks and thus cannot set out the more radical adaptation responses that could manage those risks.

3.4 Household water use

3.4.1 Introduction

The majority of climate change projections for the UK show a reduction in the amount of water available to people, industry, agriculture and the environment, compounded by increasing demand from a growing population. CCRA2 and studies by Water UK²²⁵ and the National Infrastructure Commission²²⁶ have re-emphasised the need for a 'twin-track approach' to managing water supplies. This includes both increasing supply, through greater capturing, storing and transferring of water, alongside reducing demand through more efficient use of water by households, agriculture and industry, and leakage reduction. Decision makers need to take both supply and demand aspects into account in order to give proper consideration to the risks to people and the environment and determine the most effective mix of measures in response.

Plans, such as the Water Resource Management Plans (WRMPs), and other assessments which consider demand and supply together are discussed in the water adaptation priorities in both this and Section 4.4.

Water is discussed in several chapters of this report:

- Water in the natural environment is discussed in Chapter 2: Natural environment.
- Supply-side measures and structural improvements to water company networks to reduce leakage, and be more resilient to severe weather, are discussed in Chapter 4: Infrastructure.
- Use of water by businesses and industry is discussed in Chapter 5: Business.

This section discusses progress made in reducing water use by households.

3.4.2 Water demand in the built environment

What is the risk?

CCRA2 found that, depending on the extent of climate change and population growth, the demand for water in England is projected to exceed supply by between 1,100 - 3,100 megalitres of water per day (MI/d) by the 2050s and 1,800 - 5,700 by the 2080s.

²²⁵ Water UK (2016) *Water resources long-term planning framework (2015-2065)*.

²²⁶ National Infrastructure Commission (2018) *Preparing for a drier future*.

A package of adaptation measures, including reducing per capita consumption to 92 litres per head per day (l/h/d) and leakage by approximately 70% by 2050, was found to significantly but not fully alleviate the projected deficits under a medium climate change (between a 2.5 - 4°C global temperature rise by 2100 depending on the probability level used)²²⁷ and high population scenario.

While recognising the significant action already taking place, CCRA2 identified an urgent need for longer-term water resource planning to assess the scale of risks and consider strategic options, more co-ordinated action to ensure resilient supplies especially in times of drought, and further steps to achieve the ambitious reductions in water demand and leakage that are likely to be required. Otherwise there could be increasingly difficult trade-offs between the needs of industry, farming and the public water supply, and the ecological status of rivers, lakes, estuaries, and groundwater.

CCC progress score	Reason for progress score
8	Plan score - high: Water companies are required to develop plans that are tied to their investment cycle, for adapting to the risks of future water scarcity with climate change within their Water Resource Management Plans (WRMPs). This includes plans for demand management which is a critical aspect of ensuring resilient water supplies. Risk score - medium: While a broad range of actions are being taken to reduce consumption, the level of progress in recent years and ambition in company plans may not be adequate to address future risks, particularly in the context of a 4°C global temperature scenario.

Is there a good quality plan?

Are plans covered in NAP2?

NAP2 sets out a clear intention to lower water use but a target for per capita consumption and measures to support this are still to be determined.

NAP2 referenced the 25 Year Environment Plan Goal 'to provide 'clean and plentiful water' for future generations. To increase water supply and incentivise greater water efficiency to maintain a plentiful supply as demand increases and climate change impacts availability.' It stated that working towards achieving this goal would involve encouraging companies and individuals to take a responsible approach for water saving, reducing wastage and create behaviour change, in addition to strengthening the resilience of supply whilst managing demand.

On demand management, Defra stated in NAP2 that it wants to see individual water use fall from the current levels of approximately 140 l/h/d. To achieve this it will work with the water industry, Waterwise, Water UK, and other groups to set a national target for per capita consumption, and investigate tools, techniques and policy options to achieve this.

²²⁷ Murphy, J.M., et al. (2009), *UK Climate Projections Science Report: Climate change projections*. Met Office Hadley Centre, Exeter. Page 121.

Originally scheduled for the end of 2018, the national target and supporting options are instead to be put out for consultation in 2019.

NAP2 references the existing Water Resource Management Plan process, which requires water companies to take a long-term view and model the impacts of climate change and population growth on their ability to supply customers.

Water companies already publish statutory Water Resource Management Plans (WRMPs) every five years. WRMPs set out water companies' intended approach for at least the next 25 years, with the latest round of final plans due to be published later in 2019. In these plans water companies have considered different options to meet any projected deficits or ensure resilience to future droughts. They then develop the options that form their preferred plan using decision making tools such as cost-benefit analysis, as well as feedback from their customers. Ofwat and the Environment Agency act as statutory consultees and scrutinise the measures set out in draft plans. Only after the Secretary of State has reviewed relevant advice and given permission, can water companies publish their final plans.

Future forecasts of water supply and demand in WRMPs are based on sophisticated modelling of relevant drivers, including population growth and climate change. New guidance from the Environment Agency and Natural Resources Wales recommends that water companies should test their resilience, ensuring no customers would experience measures such as stand pipes or rota cuts, to at least a 'severe' drought (1 in 200 years).²²⁸ These forecasts produce annual estimates to the end of the planning period for aspects of managing both supply and water demand, like per capita consumption (PCC) and the proportion of households which have a water meter, against which companies' actual performance can be compared.

Defra stated in NAP2 that it will strengthen the WRMP guidance for the next round in 2024. There is an opportunity to make the way water companies consider climate change and engage with their customers more consistent.

Water companies have typically used a medium emissions scenario (which in UKCP09 equates to between a 2.6 - 4.2°C global temperature rise by 2100 depending on the probability level used) when producing their projections. Some have also used a high emissions scenario (between a 3.4 – 5.3°C temperature rise depending on the probability level²²⁹) as part of their sensitivity analysis and in some such cases, have used this to determine part of their 'headroom', the buffer between projections of supply and demand to account for uncertainty. The use of a higher emissions scenario is currently not consistent across companies because a specific approach is not specified in guidance.

The requirement to ensure no customer would experience measures such as stand pipes or rota cuts, to at least a 'severe' drought (1 in 200 years) should also be reviewed. It is possible that the future financial and environmental costs, including to the environment, of avoiding such restrictions could outweigh customers' welfare losses due to such supply disruptions, if these instances are sufficiently rare. When water companies consult their customers on the level of service they provide, it is important to ensure that such trade-offs over the medium and long-term are clearly and consistently presented across companies.

²²⁸ Environment Agency and Natural Resources Wales (2018) *Water Resources Planning Guideline: Interim update*.

²²⁹ Murphy, J.M., et al. (2009) *UK Climate Projections Science Report: Climate change projections*. Met Office Hadley Centre, Exeter. Page 121.

UK Water Industry Research has published guidance reviewing current climate change evidence and methodologies and proposing an enhanced approach for the next round of WRMPs in 2024, which will make use of the UKCP18 climate projections. CCRA3 will also use UKCP18 to produce updated projections of future water availability and consider how additional adaptation could deal with any deficits identified.

Are there other plans not mentioned in NAP2?

Analysis by the National Infrastructure Commission estimates the total amount of additional water that improved demand management should aim to provide. Ofwat has emphasised the importance of more ambition on water efficiency to water companies.

The National Infrastructure Commission recommended building resilience to a 1 in 500 year drought which requires an increase in supply and reduction in demand that achieves a net increase of at least 4,000 Ml/d based on a medium emissions scenario.²³⁰ It suggested that a third of this should be provided by demand management primarily through widespread metering as a first step in a concerted campaign to improve water efficiency.

Ofwat asks water companies to make a performance commitment regarding per capita consumption. In its assessment of draft WRMPs, Ofwat identified water efficiency as an area of concern, stating there had been no step change in ambition over previous plans and highlighted the Government's goal to lower consumption in the 25 Year Environment Plan. Research commissioned by Ofwat to explore reducing household demand, finding that average household consumption of 50-70 l/h/d in 50 years is technologically possible, although the study did not consider costs or social acceptability.²³¹

Do the plans address the risks in CCRA2?

The plans in NAP2 to lower water demand in the built environment have the potential to address the risk in CCRA2 but currently lack a clear target and timescales to judge this properly. Water companies are required to take a long-term view and model the impacts of climate change and population growth on their ability to supply customers. In the latest round of draft plans, companies have proposed further improvements in demand management over the next 25 years. However, the level of ambition in these plans is below the package of measures that CCRA2 showed could significantly, but not fully, alleviate projected supply-demand deficits in a high population and medium climate change scenario, and also below what the NIC and Water UK have demonstrated is required to build resilience to more severe droughts.

Is progress being made in managing risk?

Are relevant actions taking place?

Water companies are taking a range of actions to improve water efficiency now and in the future.

Water companies are offering incentives, carrying out research, making use of social media and running education campaigns to try and lower water use in their regions now and in the future. Box 3.3 sets out some examples of this.

²³⁰ National Infrastructure Commission (2018) *Preparing for a drier future*.

²³¹ Artesia Consulting for Ofwat (2018) *The long term potential for deep reductions in household water demand*.

Box 3.3. Examples of actions by water companies to improve water efficiency

Through its River Itchen Challenge, Southern Water aimed to reduce water in part of its region with a much higher level of per capita consumption, 180 l/h/d, than the average. It offered home visits, which included the installation of free water-saving products and repairing leaks. Southern Water reported that 115 home visits had resulted in about 8% less water being used across the entire area of around 1,000 homes.

Research is being undertaken to understand how different approaches can improve water efficiency. Affinity Water worked with environmental charity Hubbub to develop the #TapChat social media engagement initiative, which has so far been estimated to save around 1,600 litres of water or an annual saving of around £29 per person.

Northumbrian Water used behavioural economics to increase participation in its water saving programmes, while Thames Water's Green Redeem scheme offers non-financial rewards to participants for lowering their water use.

There are good examples of community education campaigns and outreach to schools across water companies.

Source: Adapted by CCC from Waterwise (2018) *Water Efficiency Strategy for the UK, Year 1 Report – How is the UK doing?*

There is widespread recognition of the need for greater ambition on demand management, with Defra planning to consult on a national, non-binding target for per capita consumption in 2019 and policy options to support this.

Sir James Bevan, Chief Executive of the Environment Agency, recently stated the Environment Agency's support for Waterwise's target for the water sector of 100 l/h/d by 2045.²³² Southern Water has already announced its aim to reduce per capita consumption in its region to 100 l/h/d by 2040.²³³

Defra is committed to putting out a call for evidence on a per capita consumption target in 2019 to support the commitment for a target in the 25 Year Environment Plan. The target will be a national, non-binding target that can be used to judge the effectiveness of Government actions and those of the water industry in reducing water use. Defra plans to publish a consultation alongside the call for evidence which will ask for views on policy options to support a per capita consumption target including labelling the water efficiency of appliances, metering, building standards and behaviour change.²³⁴ This consultation addresses the NAP2 actions related to demand management in part, with some requiring further action after the consultation. For example, one of the actions is to increase metering penetration over the next 25 years, and another is to promote the use of a water label on appliances rather than just consult on it. The information collected from the consultation should be used to give these and the other NAP actions on demand management more specific outcomes.

Box 3.4 sets out our recommendations on water efficiency to Defra and Local Authorities from our recent report on UK housing.

²³² <https://www.gov.uk/government/speeches/escaping-the-jaws-of-death-ensuring-enough-water-in-2050>

²³³ Southern Water (2018). *Target 100 Act today, save tomorrow*.

²³⁴ Defra (2018) *Water conservation report*.

Box 3.4. Recommendations for improving water efficiency from the CCC's 2019 report on UK Housing

Local authorities should include water efficiency measures in energy efficient retrofit programmes. Water efficiency should be included in social housing standards such as the Decent Homes Quality Standard). (Owner: Local authorities. Timing: Ongoing.)

Defra should set a per capita consumption target which can address future supply-demand deficits resulting from both 2 and 4 degree climate change scenarios. Further research should be undertaken to understand the costs and benefits of targets between 50 and 100 litres per day by 2050. As a first step to meeting a target and improving water efficiency in homes, the UK Government should:

- Enable water companies to implement compulsory metering beyond water stressed areas by amending regulations before the end of 2019 and requiring all companies to consider systematic roll-out of smart meters.
- Review new build regulation standards to allow local authorities to set more ambitious standards, especially in current and future water-stressed areas.
- Introduce compulsory water efficiency labelling of household water products.
- Work with water companies and local authorities to run partnership retrofit and behaviour change programmes in existing homes. (Owner: Defra. Timing: by 2021).

Source: CCC (2019) *UK Housing: Fit for the Future?*

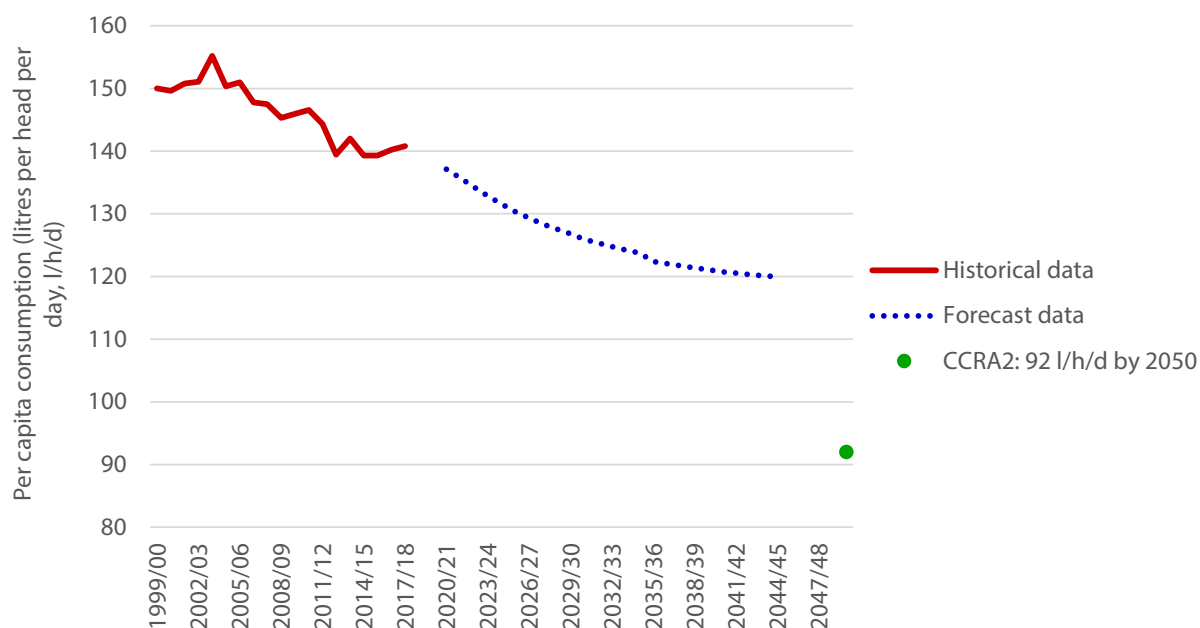
Is there evidence that risk is being managed?

Per capita consumption (PCC) has decreased over the past 20 years but in recent years progress has stalled. While this round of WRMPs sets out further improvements in water efficiency over the next 25 years, the outcome for PCC is below what could be required to address the supply-demand deficits under a high population and medium climate change scenario in CCRA2.

Figure 3.10 shows that domestic water consumption in England has fallen from 155 l/h/d in 2003/2004 to 141 l/h/d in 2017/2018. There will be variation from year to year due to a variety of factors such as a particularly hot summer. However, this is roughly the same level as five years ago. Based on this recent level of progress, the sector is no longer on course to achieve the level of PCC based on the 2014 WRMPs of 137 l/h/d by 2020.

The CCRA2 water projections research project found that a package of adaptation measures, including per capita consumption of 92 litres per head per day (l/h/d) by 2050 could significantly, but not fully alleviate projected future supply-demand deficits under a high population and medium climate change scenario. Figure 3.10 sets out forecast data from WRMPs which shows that collectively water companies estimate that they will reduce per capita consumption from its current level to around 120 l/h/d by 2045.

Figure 3.10. Weighted average per capita consumption in England from 1999/2000 to 2017/2018 and forecast data for 2020/2021 to 2044/2045



Sources: CCC analysis; ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*; Environment Agency (unpublished at time of writing); HR Wallingford et al. for the CCC (2015) *CCRA2: Updated Projections for Water Availability for the UK: Final Report for the Adaptation Sub-Committee*.

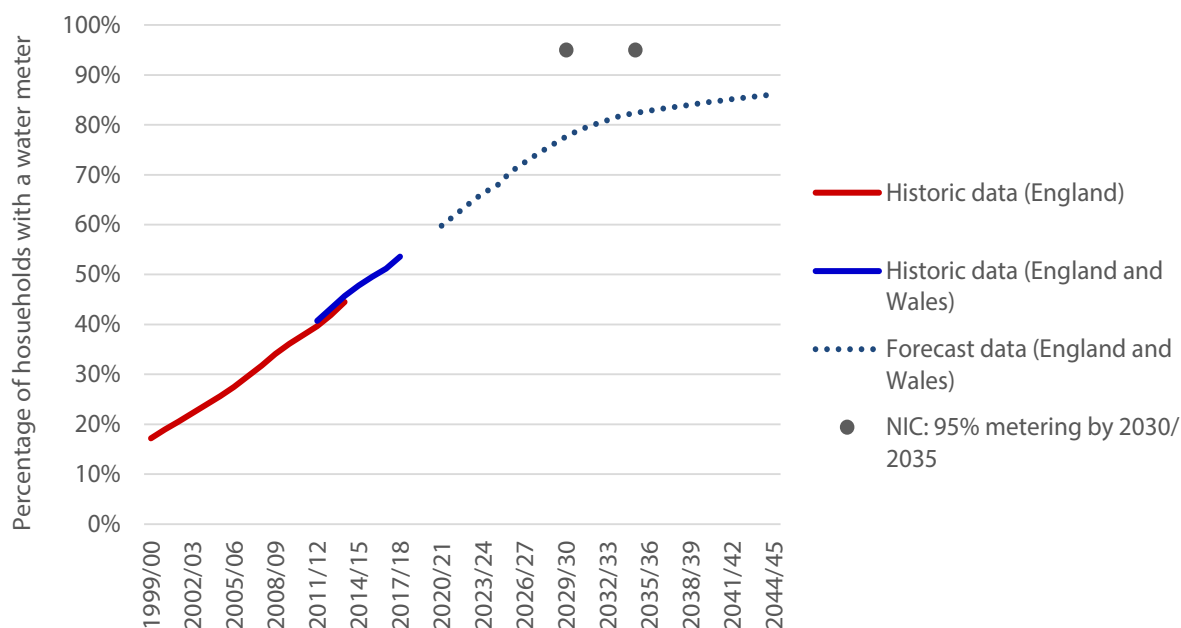
Notes: Forecast data are based on the latest revised draft Water Resources Management Plans (WRMPs). These forecast data may differ from those in later revised draft and final WRMPs. CCRA2 found that a package of adaptation measures, including per capita consumption of 92 litres per head per day (l/h/d) by 2050 could significantly, but not fully alleviate projected future supply-demand deficits under a high population and medium climate change scenario (between a 2.5 - 4°C global temperature rise by 2100 depending on the probability level used).

Metering of households is steadily increasing but faster uptake could save large amounts of water and would be at worst cost-neutral.

Figure 3.11 shows that the proportion of households with water meters has steadily increased from 17% in 1999/2000 to 54% in 2017/2018. Water companies' forecasts suggest this level of progress will be similar over the next decade. The forecast data from WRMPs in Figure 3.11 shows that collectively water companies estimate that they will increase the percentage of households with a water meter to around 78% by 2030.

The National Infrastructure Commission assessed the potential benefits of metering compared to a baseline of continuing at the current rate of meter roll-out with near universal (95% of households) conventional and smart metering by 2030 and 2035. The total amount of water that would be saved in 2050 ranged from 400 - 800 Ml/d depending on the type of metering. The results suggest that, if wider benefits are included, such as the savings from avoided energy use and less infrastructure construction, quicker and more comprehensive smart metering should result in savings and is at worst cost neutral.

Figure 3.11. Percentage of households in England and Wales with water meters from 1999/2000 to 2017/2018 and forecast data for 2021/2022 to 2044/2045



Sources: CCC analysis; ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*; Environment Agency (unpublished at time of writing); National Infrastructure Commission (2018) *Preparing for a drier future*.

Notes: Forecast data are based on the latest revised draft Water Resources Management Plans (WRMPs). These forecast data may differ from those in later revised draft and final WRMPs. Data include void properties. Data are also included for Wales due to recent changes in the boundary of Hafren Dyfrdwy, as well as Severn Trent, which operates across both regions. The inclusion of these two companies in the dataset make relatively little difference on the results, with the percentage difference being less than 1% for each year between 2011/2012 and 2016/2017. The National Infrastructure Commission assessed the potential benefits of metering compared to a baseline of continuing at the current rate of meter roll-out with near universal (95% of households) conventional and smart metering by 2030 and 2035. The total amount of water that would be saved in 2050 ranged from 400 - 800 Ml/d depending on the type of metering. The results suggest that, if wider benefits are included, such as the savings from avoided energy use and less infrastructure construction, quicker and more comprehensive smart metering should result in savings and is at worst cost neutral.

Conclusion

The WRMP process requires water companies to develop good plans for adapting to the risks of future water scarcity. This includes plans for demand management which is a critical aspect of ensuring resilient water supplies. While a broad range of actions are being taken to reduce consumption, the level of progress in recent years and ambition in company plans may not be adequate to address future risks, particularly in the context of a 4°C global temperature scenario.

3.5 Public health and wellbeing

Introduction

The impacts of climate change on people will, to a significant degree, be determined by how well the built environment is adapted to future climate. The impacts on people from flooding are described above, but heat also poses a significant threat now and in the future. The latest UK climate projections suggest average daily maximum temperatures will continue to rise. With future warming Met Office UKCP18 projections show that by mid-century hot summers (like summer 2018) could become even more common (with probabilities of the order of 50% more likely depending on the emissions scenario followed - see Chapter 1).

Temperature rise will increase the risk of overheating in buildings. The average outdoor temperature thresholds in England at which populations begin to show heat-related mortality and morbidity vary regionally from around 17°C to 20°C.²³⁵ The UK Government recognises that heat impacts are disproportionately higher for vulnerable groups (for example the elderly or those with existing health conditions), due to a combination of exposure, higher sensitivity and lower capacity to respond (including through support networks). Vulnerable people are more likely to suffer increased fatalities from cardiac and respiratory disease during hot weather and heatwaves. The average number of heat-related deaths in the UK is expected to more than triple to 7,000 a year by the 2050s, in the absence of additional adaptation.²³⁶

There are also more uncertain but potentially large impacts on air pollution levels and threats from climate-sensitive infectious and non-infectious diseases. These changes are likely to alter the weather-related burden on human health and wellbeing.

Health impacts from changes in UV is not included as an adaptation priority in this report because there is not sufficient evidence at present on the link between climate change and future risk.

3.5.1 Health impacts from heat and cold

What is the risk?

CCRA2 highlighted that there is likely to be a significant adaptation shortfall to manage the increasing risks to health from higher temperatures in the future.

Homes are not adapted for current or future high temperatures, there is a lack of awareness of the risks to health from high indoor temperatures, and a lack of appropriate planning in health and social care. CCRA2 identified a number of adaptation gaps, where more action is needed to reduce risks from heat and cold in buildings, in order to deliver health and social care; and on public transport. CCRA2 sets out that:

- In buildings, new designs are needed to avoid lock-in to a maladapted housing stock in the future, policies to improve energy efficiency and reduce fuel poverty should be strengthened together with new steps to reduce overheating risks, and more is needed to adapt existing buildings.

²³⁵ CCC (2014) *Managing climate risks to well-being and the economy: ASC progress report 2014*.

²³⁶ Kovats, R.S., and Osborn, D., (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 5, People and the Built Environment*.

- In healthcare facilities, better monitoring of the impacts of overheating on patients and infrastructure is needed, alongside severe weather and adaptation plans. Plans are also needed that consider how the future move towards home-based care alters the risks to patients and healthcare delivery from extreme weather.
- More information and better communication is needed to improve awareness of risks to health from high indoor temperatures, and the measures people can take to protect themselves.
- The action underway in London to assess and manage risks of overheating on public transport should continue, together with similar action as needed elsewhere.

CCC progress score	Reason for progress score
2	Plan score - low: Short-term plans exist to provide guidance during hot and cold weather, however, longer term adaptation plans to mitigate the long-term risks of climate change are missing, despite CCRA2 highlighting the risks to health from heat as an urgent priority. Plans are in place to review the Building Regulations, but as yet, there are no significant shifts in policy to ensure that new buildings are being designed with the future climate in mind and no policies exist to help to adapt existing buildings. Risk score - medium: Actions are taking place, for example the NHS are beginning to embed adaptation into Sustainable Development Plans, the Department for Education has published revised guidelines on ventilation, thermal comfort and indoor air quality in schools, actions to improve passenger comfort and safety in hot weather on transport are occurring and the Ministry of Justice uses climate projections to help to mitigate risks in prison buildings. However, around 20% of existing homes currently overheat even in cool summers, while demand for air conditioning is increasing. The proportion of urban greenspace is declining, action to improve energy efficiency has stalled and little is being done to monitor and protect care home residents. Regulations should be strengthened for overheating to prioritise passive cooling measures in existing and new buildings. There is a need for increased and improved data collection in healthcare facilities, and better indicators to monitor overheating in homes.

Is there a good quality plan?

Are plans covered in NAP2?

1. Buildings

NAP2 does not set out a coherent plan for implementing the adaptations required for existing or new homes to be safe and habitable in increasing temperatures.

NAP2 highlights some aspects that could come together to form a plan, but these are not (yet) presented as part of a wider strategy that considers the long-term risks from climate change:

- It repeats the 25 Year Environment Plan (25-year Plan) goal to create more Green Infrastructure (GI), plant one million urban trees and develop a set of GI standards, which could help to reduce the Urban Heat Island Effect.
- The NHS has introduced overheating reporting and adaptation plans in hospitals, and the Department for Education has published revised building guidelines.

NAP2 also clearly states that new housing policy is needed to consider addressing large-scale refurbishment of the existing housing stock, including industry guidance to avoid maladaptation. However, the actions within NAP2 do not properly address these issues (see below).

There remains a need for a plan that at least prepares England's housing stock for a 2°C increase in global temperature by 2100, with consideration of much more extreme changes. Some of the gaps that still need to be filled are better understanding of the current risk of overheating, and guidance on how to target effective cooling strategies in existing homes and public buildings.

The technology exists to deliver homes which have high levels of thermal efficiency, are better adapted to a changing climate, with safe moisture levels and with excellent indoor air quality. As reported in the CCC's housing report, a holistic approach in current design and build practices is lacking and this can lead to quality issues.²³⁷ Close interlinkages between these various objectives drive the need to consider them alongside one another. MHCLG will be reviewing Building Regulations that deal with energy and ventilation in 2019 (see below).

2. Health and social care delivery

NAP2 sets out an adverse weather plan to address gaps in awareness raising, guidance and strategic planning for dealing with extreme weather when delivering health and social care. However, it does not include a plan to address the lack of understanding of the extent of overheating risks in care facilities or how a move towards home-based care may alter the risks to patients and healthcare delivery from extreme weather.

The Heatwave and Cold Weather Plans are due to be combined and replaced with an Adverse Weather and Health Plan in 2022, covering heat, cold and other climate risks identified within CCRA2. This plan should extend focus to include long-term strategic planning as well as emergency response. The draft implementation plan includes indicators for monitoring progress of stated activities.

²³⁷ CCC (2019) *UK Housing: Fit for the future?*

3. Public Transport

NAP2 states that DfT will continue to work with infrastructure managers to extend the provision for regulating temperatures at stations and on public transport across the country, but does not include a plan for adapting the transport network to higher temperatures.

Are there other plans not mentioned in NAP2?

The updated National Planning Policy Framework includes a requirement to consider risks from overheating in new developments, but has also removed support for energy efficiency improvements to buildings.

Local authorities are also well-placed for preparing for the impacts of climate change through local planning. However, the extent to which adaptation is included in local authority strategies varies.²³⁸ Local planning policies can reinforce the need for new developments to be planned and designed to manage internal temperatures (for example with regards to orientation, shading, window design and ventilation).

The NPPF was updated in 2017 and now includes a requirement for local plans to consider overheating risk. Planning Guidance is due to be updated and the Committee recommended in the 2019 housing report that this guidance should contain a requirement for local authorities to include an assessment of overheating risk as part of the planning process. This should require housing developers to carry out an initial assessment of the strategic features that increase risk, such as site location, building layout, façade, greenspace availability, and introduce appropriate mitigation measures at the early planning stage. Shaded spaces in urban areas should be included in the NPPF section on 'promoting healthy and safe communities', so that all local planning authorities have to demonstrate their provision of shaded spaces in the clearance process of local plans.

Updates to the NPPF have removed the requirement for active support for energy efficiency improvements to existing buildings. For new builds, Government has clarified that Local authorities are permitted to set tighter standards than those in building regulations, but for homes these standards can only be set up to the equivalent of Level 4 of the Code for Sustainable Homes (approximately 20% above current Building Regulations across the build mix).²³⁹

Overheating risks are not adequately addressed in the current Building Regulations. Current regulations cover overheating only in terms of conserving fuel and power from use of air conditioning. This approach is not adequate for identifying current or future levels of overheating.

MHCLG has committed to review Part L, relating to power and Part F, relating to ventilation of Building Regulations in 2019, alongside consulting on a method for reducing overheating risk in new homes. The risk of overheating in terms of minimising risks to health and safety of occupants should be enshrined into regulations for new build homes and retrofits. This should be considered alongside an integrated review of energy efficiency and ventilation, and be included in the Government's planned Future Homes Standard, to include improvement in the measurement of current and future overheating risk and prioritise passive cooling measures.

²³⁸ Sarah Woodhall (2018) *Climate Change and Risk Assessment in Local Authorities in England: A health policy report*.

²³⁹ See: <https://www.gov.uk/guidance/climate-change>

To promote healthier urban areas, the 25 Year Environment Plan includes an aim to green towns and cities by creating green infrastructure and planting one million trees.

Treasury has allocated £10 million to deliver an Urban Tree Challenge Fund to plant at least 20,000 larger sized trees and 110,000 smaller trees in and around urban areas between 2019 and 2021.²⁴⁰ It is not clear if this target is on track. Greenspace is an important adaptation measure for managing overheating as it can provide shading and reduce the Urban Heat Island effect. It also improves drainage and surface water flood risk if implemented properly and brings a host of wider benefits to people and wildlife, increasing the economic benefits of green infrastructure.^{241, 242} People living in the most deprived areas are less likely to live in the greenest areas, and will therefore have less opportunities to gain the health benefits of greenspace compared with people living in less deprived areas. Greenspace can also be integrated into towns and cities through public parks and gardens.

The NHS Outcomes Framework and Heatwave Plan include specific outcomes to reduce summer deaths and illness, but these have not yet fed through into other policies related to overheating.

The NHS Outcomes Framework includes a goal to prevent people from dying prematurely. The existing Heatwave Plan for England (see below) also has a related goal to reduce summer deaths and illness by raising public awareness and triggering actions in the NHS, public health, social care and other community and voluntary organisations to support people who have health, housing or economic circumstances that increase their vulnerability to heat.

The Heatwave and Cold Weather Plans for England provide guidance to health, social care and community practitioners and the public in order to protect vulnerable people in hot and cold weather respectively, but do not constitute a comprehensive long-term adaptation plan to reduce the risk of heat- and cold-related mortality and illness.

The Department for Health and Social Care (DHSC) commissioned the Policy Innovation & Evaluation Research Unit (PIRU) at the London School of Hygiene and Tropical Medicine to carry out a review of the Heatwave Plan in 2018 (Box 3.5). The findings will be published in 2019. Draft findings show little evidence that the current Heatwave Plan has reduced general summertime impacts of heat on health since it was introduced, although it may have contributed to lower impacts observed during recent heat-wave events. However, as most of the heat-related mortality occurs at more moderate temperature, it is not unexpected that a shift in the overall heat mortality relationship was not evident. Such a shift would require tackling the wider determinants that drive the excess mortality from high temperatures, such as housing. The review also found that local authorities and health services vary in their approach to implementing the Plan, with some organisations being ill prepared for severe heat events.

²⁴⁰ Appendix A - NAP action update.

²⁴¹ Wider benefits include maintaining and improving freshwater quality and supply, supporting biodiversity, providing amenity value to people, health benefits and providing spaces for walking and cycling.

²⁴² Watkiss, P., Cimato, F., Hunt, A. and Moxey, A. for the CCC (2019). *The Impacts of Climate Change on Meeting Government Outcomes in England*.

Box 3.5. Heatwave Plan for England - Draft findings from evaluation

The study examined the contribution of the Heatwave Plan for England (HWP) to protecting the health of the population during hot weather. The research included analysis to establish the relationship between hot weather and adverse health outcomes; cases studies of local implementation of the Plan in five areas in England, along with a national survey of nurses in hospital, community and care home settings, to investigate HWP awareness and implementation during heat-health alerts; and a survey of the general public, as well as focus groups conducted with 'high-risk' individuals, to explore whether people protect themselves and others by following the advice set out in the plan. Key findings included:

- There is no evidence that general summertime relationships between temperature and mortality, and between temperature and emergency hospital admissions have changed substantially in the years since the introduction of the first HWP in 2004. However, there was an observed reduction in the adverse health impacts of recent post-2004 heatwaves (i.e. periods of very hot weather), to which the HWP may have contributed.
- Heatwave planning by local authorities was largely seen as an exercise in emergency preparedness and focused on 'warning and informing' through the alert system, rather than as part of strategic long-term public health and environmental planning.
- Heatwaves were frequently assessed by local authorities as lower risk than other weather-related hazards such as floods and cold weather, and were often given a lower priority in planning. By assigning priority based on current risk, planners were not preparing for future increases in risk associated with climate change.
- Many frontline health and social care staff reported being unaware of any local heatwave plans, and were unfamiliar with the HWP guidance. Despite staff reporting that they knew how to manage patients during hot weather, not all the actions stated by frontline staff during the 2017 and 2018 heatwaves were appropriate or in line with HWP guidance, and many reported taking few or none of the recommended HWP actions during an alert period.
- Many frontline nurses surveyed said that they were working in difficult and challenging conditions: often in poorly designed buildings not well adapted for climate change. They reported a lack of resources to implement many HWP actions and frequently organisational policies that were insufficiently flexible in hot weather.
- Most adults, including those considered most vulnerable to the effects of heat, do not consider themselves at risk from hot weather, and those who do not perceive the risk are less likely to take protective actions during a heatwave.
- Only a very small proportion of vulnerable adults are likely to be contacted by health professionals during a heatwave to check how they are.

Source: London School of Hygiene and Tropical Medicine (2019) *Evaluation of the Heatwave Plan for England – Draft Final Report, pre-review copy (pending external review)*.

Do the plans address the risks in CCRA2?

Significant gaps remain which should be addressed urgently.

- There remains a need for a plan that at least prepares England's housing stock for a 2°C increase in global temperature by 2100, with consideration of much more extreme changes.
- The CCC's housing report recommended that Building Regulations should be updated with tighter standards to deliver ultra-high levels of energy efficiency, alongside being designed for a changing climate, properly ventilated and moisture-safe. The risk of overheating in terms of minimising risks to health and safety of occupants should be enshrined into regulations for new build homes and retrofits.
- A plan to address the lack of understanding of the extent of overheating risks in care facilities is needed. This should include how the future move towards home-based care alters the risks to patients and healthcare delivery from extreme weather. This work is needed now to create the right conditions for future care models to be flexible and resilient to shocks from extreme weather.

Is progress being made in managing risk?

Are relevant actions taking place?

The National Adaptation Programme (NAP2) include some actions relating to overheating in buildings and delivery of health and social care services, which are progressing. These may help reduce vulnerability as they develop further.

Examples of actions taking place include:²⁴³

- Following our recommendation in 2017 to introduce a standard or regulation to reduce the risk of overheating in new homes the Government has commissioned research to provide a better understand the overheating risk in new dwellings in England and the effectiveness of adaptation measures to help industry and others mitigate risk. The results of the report are due to be published alongside the Building Regulation consultation.
- The health sector aims to embed adaptation into daily practice by 2023, by including it as a key element of Sustainable Development Management Plans (SDMPs) for which there is a requirement of 100% coverage for NHS providers:
 - The Sustainable Development Unit and NHSI have published joint guidance on including adaptation within SDMPs.
 - Since April 2017 the NHS has required Trusts and commissioners as part of their Estates Return Information Collection (ERIC) to submit data on the percentage of clinical areas covered by thermal monitoring; the number of overheating events in clinical areas; the presence of an organisational adaptation plan; an expectation of coverage of adaptation in mandatory Sustainable Development Management Plans (SDMP); and an expectation of coverage of adaptation in Trusts' annual reports.
 - In 2017/18 34% (78) of NHS providers had an approved adaptation plan, up from 32% the previous year.²⁴⁴

²⁴³ Appendix A - NAP action update.

²⁴⁴ NHS Estate Returns Collections Data, 2016-2018.

- Public Health England (PHE) has published additional guidance in 2017/18 for some sectors:
 - 'Beat the Heat' guidance aims at keeping care home residents safe and well in hot weather. The guidance provides a questionnaire that care home managers can complete to assess the risk for their residents. Where a risk is identified, the guidance signposts the manager to the Heatwave Plan for England and associated guidance.
 - Heatwave guidance for teachers and for early year's settings was published in consultation with the Department for Education (DfE).
- In prisons the Ministry of Justice (MoJ) keeps the design of prisons under continual review. This includes identifying what can be done to mitigate the risks of overheating in prison buildings. MoJ has used UKCP09 to allow designs to be 'future-proofed' within the Prison Estate Transformation Programme (PETP) modelling. This aims to ensure that summertime overheating is not a significant problem, and that the energy used by future cooling demands is minimised through the design stage. In existing buildings, passive cooling is used to control temperature and guard against overheating.²⁴⁵
- The Department for Education (DfE) has published revised guidelines on ventilation, thermal comfort and indoor air quality in new and refurbished schools.²⁴⁶ It sets out the regulatory framework and gives performance levels for compliance with UK regulations and further non-statutory guidance. It includes a section giving information on climate change adaptation, however it does not provide a list of specific actions. It will be reviewed in 2022. DfE are also undertaking a Climate Change Adaptation study to understand the impact of future climate on the new and existing school building stock.

The Department for Transport, Network Rail and London Underground are taking action to improve passenger comfort and safety in hot weather on transport.

Examples include:²⁴⁷

- Network Rail guidelines for the management of hot and cold weather events.
- Network Rail introduces speed restrictions should there be a risk of rails moving due to temperature rises.
- London Underground is rolling out air-conditioned stock on sub-surface lines.
- DfT is continuing to work with infrastructure providers for regulating temperatures at stations and public transport across the country.

Transport organisations should ensure that risks to passenger comfort from climate change is included within the next round of Adaptation Reporting Power (ARP) reporting.

NAP2 also includes plans to improve the evidence base:

- PHE and DHSC will continue to undertake research to understand the health consequences of climate change more comprehensively and the health interventions which are effective at minimising preventable harm.

²⁴⁵ Defra (2018) *The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting*.

²⁴⁶ Education and Skills Funding Agency (2018) *Building Bulletin 101 Guidelines on ventilation, thermal comfort and indoor air quality in schools*.

²⁴⁷ Defra (2018) *The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting*.

- The evidence base for health impacts of climate change will be strengthened through publication by 2023 of an update of the report ('Health Effects of Climate Change in the UK') based on UKCP18.

Is there evidence that risk is being managed?

Vulnerability to overheating still does not appear to be improving.

The Environmental Audit Committee undertook an inquiry into heatwaves in 2018. The key findings were that failing to address the danger of heatwaves and higher temperatures will threaten the wellbeing of an increasing number of vulnerable people.²⁴⁸ Safe upper temperature thresholds for health are difficult to establish and there is currently no standard metric to quantify the risks and health impact of overheating in buildings.

A number of the CCC indicators and other evidence show that vulnerability to current and future high temperatures in homes is increasing. However, better indicators are needed:

- An investigation by MHCLG carried out in 2015 found that 'all new homes exceed the overheating threshold to some extent.'²⁴⁹ As reported in 2017, studies also show that 20% of existing homes overheat in relatively cool summers.²⁵⁰
- The demand for air conditioning units has grown by 17% between 2011 and 2017 in UK buildings:²⁵¹
 - In 2017, there was demand for 188,000 of these air conditioning units; compared to 161,000 units in 2011.²⁵² This increase could be expected due to a combination of increased housing coupled with a warming climate.
 - Air conditioning is energy-intensive and expels waste heat into the environment. Units can increase carbon emissions (if powered from non-renewable energy), contribute to the Urban Heat Island Effect and increase occupant bills (potentially increasing the risk of summer-time fuel poverty).²⁵³
 - Passive cooling measures should be adopted to reduce overheating risks before considering active measures such as air conditioning. There is a need to scale up home retrofit programmes to include consideration of overheating risks and passive cooling when promoting the implementation of energy efficiency and ventilation interventions.

Better indicators would help to understand overheating in existing homes, target appropriate mitigation measures and allow progress in managing risk to be measured. Useful indicators include: ongoing monitoring of temperatures in the housing stock; monitoring of overheating exceedances in homes; number of homes currently adapted.

²⁴⁸ EAC (2018) *Heatwaves: adapting to climate change*.

²⁴⁹ Government response to EAC 2018 Heatwaves inquiry. See: <https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/1671/167102.html>

²⁵⁰ CCC (2017) *Progress in preparing for climate change*.

²⁵¹ This includes the total AC demand for houses, buildings, and other structures comprising demand of "Room Air Conditioners (RAC)", including window and small-sized type of units, as well as "Packaged Air Conditioners (PAC)." No data was found for air conditioning sales.

²⁵² ADAS for the CCC (2019) *Research to provide updated indicators of climate change risks and adaptation action in England*.

²⁵³ CCC (2019) *UK Housing: Fit for the future?*

Data are now being collected on overheating instances in hospitals.

Lightweight 1960s hospital designs are more vulnerable to overheating during hot weather compared with older, traditionally built blocks.²⁵⁴ The limited data available for the first two years of Estates Return Collection (ERIC) available on the number of Hospital Trusts that experience overheating show that a total of 5,442 overheating occurrences were recorded across all NHS Trusts, of which 2,980 overheating occurrences were in 2016-2017 and 2,462 in 2017-2018. However, as the data are newly collected, with potential inconsistencies in data recording, the results should be interpreted with caution. NHS and Sustainable Development Unit (SDU) should work with Trusts to ensure that data is collected in a more uniform, robust way.²⁵⁵

The NHS is in the process of re-designing the voluntary Premises Assurance Model (PAM) to include whether an organisation has a Climate Change Adaptation Risk Assessment and whether they report on estate-related events such as extreme weather (including flooding, heatwave and cold weather events).²⁵⁶

Alongside hospitals, people within the care sector may also be more vulnerable and less able to adapt because of age and reduced ability to react.

Care homes are not required to report against the NHS England's core standards of Emergency Preparedness, Resilience and Response.²⁵⁷ There has been relatively little in the way of data collected on the occurrences and impacts of overheating in care homes. Whilst there is anecdotal evidence of overheating being an issue in some NHS facilities and in care homes, the extent of this problem is not currently well understood.²⁵⁸

- A study in 2016 assessed overheating in care homes through four case studies in England and found them all to overheat during the summer of 2015 with a general lack of awareness of the impacts of overheating.²⁵⁹
- More recent studies in Scotland found a significant lack of data that would enable a robust assessment of overheating in in-patient areas; noting that it may not be appropriate to link common overheating 'issues' to common building archetypes, due to the complex, and in many cases, site specific nature of thermal comfort and overheating issues in healthcare buildings.²⁶⁰

²⁵⁴ ADAS for the CCC (2017) *Research to provide updated indicators of climate change risk and adaptation action in England*.

²⁵⁵ ADAS for the CCC (2019) *Research to provide updated indicators of climate change risks and adaptation action in England*. ERIC is a mandatory collection for all NHS Trusts. The overheating item of the survey records where wards, for each of the 236 NHS trusts, exceeded a daily maximum temperature of 26°C. The count provided in the survey includes each occupied ward or clinical area having a daily maximum of over 26°C as one incident. At any time of the year where temperatures are found to exceed 26°C, a risk assessment should be carried out and appropriate action taken to ensure the safety of vulnerable patients.

²⁵⁶ Discussion with NHS (2019).

²⁵⁷ EAC (2018) *Heatwaves: adapting to climate change*.

²⁵⁸ See: <https://www.climateexchange.org.uk/research/projects/the-risk-of-overheating-in-healthcare-buildings/>

²⁵⁹ Gupta et al. (2016) Overheating in care settings: magnitude, causes, preparedness and remedies. *Build Res Inf*, 45 (1-2), 83-101.

²⁶⁰ ADAS for the CCC (2019) *Research to provide updated indicators of climate change risks and adaptation action in England*.

Research for the CCC has identified a risk of short-term lock-in, associated with the additional numbers of elderly people requiring care (projected in this study to be 90,000 by 2025 and 190,000 by 2035).²⁶¹ A failure to plan heat management in new care homes and care in the home could lock-in large numbers of people to heat risks. Adaptation options, focusing on health and social care organisations, can offer a targeted approach for reducing heat-related mortality in vulnerable groups (and therefore could be more cost-effective for tackling health impacts than heat management measures in the built environment). Low-regret options include better forecasting of events, better information and monitoring of risks, enhanced risk preparedness and enhanced risk response. These should be actioned alongside a wider set of adaptation actions for reducing heat exposure in buildings in general and the urban environment.

The CCC have previously recommended that the Care Quality Commission should inspect for heat resilience, and ensure that overheating risk forms part of its inspection for safety and suitability of health and social care premises.

The proportion of urban greenspace is declining.

CCC analysis has found that:

- The total proportion of urban greenspace in England declined between 2001 and 2018 from 63% to 55% of urban areas. Though there had been no change between 2011 and 2016, the area declined a further 1% between 2016 and 2018.²⁶² As well as concerns over the decline in the amount of urban greenspace, access to greenspace is not equal across the population.²⁶³
- The green roof market has increased by 33% from £26.2 million in 2015, to £34.9 million in 2017. This growth equated to substrate area increase from just under 400,000m² to just over 500,000m² (around 70 football pitches).²⁶⁴

As recommended in the CCC's 2019 housing report, the Government should introduce an urban greenspace target to reverse the decline and ensure towns and cities are adapted to more frequent heatwaves in the future and that the 25-Year Plan goals are met.

Cold related deaths will remain significant and mitigation action to improve energy efficiency of homes has stalled. There is a need for an integrated approach to housing and thermal comfort.

Although average temperatures are expected to increase, cold is likely to remain a significant health problem in an ageing population. Cold related deaths per year are projected to fall, but are projected to remain around three times higher than those related to heat.²⁶⁵

Energy efficiency uptake has stalled in existing homes, with installation rates remaining well short of our published indicators.²⁶⁶ New homes continue to be built to minimum standards of energy efficiency (only 1% of new homes in 2018 were EPC A).²⁶⁷

²⁶¹ Watkiss, P., Cimato, F., Hunt, A. and Moxey, A. for the CCC (2019). *The Impacts of Climate Change on Meeting Government Outcomes in England*.

²⁶² ADAS for the CCC (2019) *Research to provide updated indicators of climate change risks and adaptation action in England*.

²⁶³ Brown, K.A. and Mijic, A. (2019) *Integrating green and blue spaces into our cities: Making it happen*. Grantham Institute Briefing Note, Imperial College London.

²⁶⁴ ADAS (2019) for the CCC. *Research to provide updated indicators of climate change risks and adaptation action in England*.

²⁶⁵ CCC (2014) *Managing climate risks to well-being and the economy: ASC progress report 2014*.

²⁶⁶ CCC (2018) *Reducing UK emissions - 2019 Progress Report to Parliament*.

²⁶⁷ CCC (2019) *UK housing: fit for the future?*

Although EPC rating has improved between 1996 and 2016, this increase is slowing with no change between 2015 and 2016 and fuel poverty rates continue to fluctuate (11% in 2016).²⁶⁸

Conclusion

Although there are a number of plans in place, these are mostly short-term or only provide guidance. Longer-term strategies are needed, in particular for existing buildings and care facilities. There is evidence of actions taking place that may lead to a reduction in risk as they progress, but vulnerability to climate change is still increasing in the meantime.

3.5.2 Risks to people from pathogens

What is the risk?

CCRA2 identified the risks to human health from vector-borne pathogens as an urgent research priority, and recommended further work on surveillance and monitoring of emerging infections.

CCRA2 highlighted the potential for increases in risk from Lyme disease, and the introduction of new vector-borne diseases to the UK (such as West Nile fever, dengue, chikungunya and Zika). Higher temperatures in the future will increase the suitability of the UK's climate for invasive mosquito species, such as *Aedes albopictus*, that are vectors for these diseases. Lyme disease may shift in altitude and incidence in the UK in response to climate change. However, other factors such as environment, behaviour, human travel and trade can play a more important role than climate in the emergence and spread of some vectors.²⁶⁹ Therefore, the future magnitude of risk is uncertain.

²⁶⁸ CCC (2019) *UK housing: fit for the future?*

²⁶⁹ Kovats, R.S., and Osborn, D., (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 5, People and the Built Environment*.

CCC progress score	Reason for progress score
2	Plan score - low: NAP2 does not fully address this priority or align to CCRA2. The 25 Year Environment Plan includes a goal to tackle invasive, non-native species by continuing to implement the GB invasive non-native species strategy. However, this strategy does not currently consider human health and wellbeing, and in any case excludes species that may arrive in the UK due to climate change in the definition of 'invasive'. Other plans exist, such as PHE's Strategic Plan to 2020 and the cross-government contingency plan for invasive mosquitos (which includes running a nationwide mosquito surveillance project), but it is not clear if these consider the long-term risks from climate change. Risk score - medium: - Existing surveillance programmes, risk analysis and contingency planning is in place. Even so, the current level of surveillance of pathogens such as ticks and mosquitos should be improved. - Increases in vector abundance are increasing human exposure to Lyme disease, however it is not known whether climate change is a driving factor. More research and indicators are needed to quantify the impact climate change has on these and other changes in exposure to relevant vectors compared to other influential factors.

Is there a good quality plan?

Are plans covered in NAP2?

NAP2 does not fully address this priority in response to impacts on health.

It includes an aim for PHE and DHSC to review and update health research strategies by 2020 to ensure CCRA research priorities, including vector-borne pathogens are addressed. However although this is an aim, it is not included as a NAP2 action.

The 25 Year Environment Plan includes a goal to tackle invasive, non-native species by continuing to implement the GB invasive non-native species strategy.²⁷⁰ The NAP includes mention of the strategy which aims to establish contingency plans for high priority new arrivals.²⁷¹ However, species that arrive in the UK due to climate change are not currently classed by the Government as 'invasive', and therefore would not be included in the strategy (see Chapter 2). In addition, this strategy does not currently consider human health and wellbeing. For example, the invasion of the Asian hornet has been highlighted for its impact on bee health, but it may also affect human health. Thus, at present the contingency plan for introduction of the Asian hornet is likely to fail to address any human health issues. There is a need for better integration of human health and climate change issues within the Invasive Non-native Species Directorate as a part of an inter-sectoral response.

²⁷⁰ HM Government (2018) *A Green Future: Our 25 year plan to improve the environment*.

²⁷¹ Defra, Scottish Government and Welsh Government (2015) *The Great Britain Invasive Non-native Species Strategy*.

Are there other plans not mentioned in NAP2?

Other plans exist that consider invasive species and food-borne diseases, but these do not consider the long-term risks from climate change.

PHE's Strategic Plan to 2020 does not include risks from vector-borne disease. However it does include an aim to increase understanding of the importance of environmental determinants of health, including climate change. There is also a cross-government contingency plan in place for dealing with invasive mosquitoes led by PHE.²⁷² This includes running a nationwide mosquito surveillance project. It is not known if this takes account of climate change.

Vector-borne diseases are mentioned within the National Risk Register.²⁷³ However, this does not take account of any future long-term climate change.

The Food Standards Agency Foodborne Diseases Strategy 2010-2015, published in 2011, included horizon scanning activities to consider future risks from food-borne pathogens. This strategy does not appear to have been updated in recent years.

Do the plans address the risks in the CCRA?

The plans that exist, as outlined above, do not provide enough detail to establish whether or not they will fully address the research priority for further work on surveillance and monitoring of emerging infections.

Is progress being made in managing risk?

Are relevant actions taking place?

NAP2 includes the following actions which are either complete or on-track:²⁷⁴

- Use Public Health England's invasive vector surveillance programme to develop and update understanding of the status, distribution and abundance of potential vector species. Monitor changes to status, distribution and abundance of potential vector species.
- Enhance the cross-government contingency plan for dealing with invasive mosquitoes to cover other veterinary and medically important insect vectors. Continue to monitor the spread and establishment of invasive species.

These actions fall under plant and animal disease and biosecurity sections of the NAP rather than people and the built environment.

Existing surveillance programmes, risk analysis and contingency planning is in place. Even so, the current level of surveillance of pathogens such as ticks and mosquitos should be improved.

Current surveillance programmes are in place for invasive mosquitos and their pathogens, and tick-borne diseases such as Lyme disease:

²⁷² Defra (2018) *The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting*.

²⁷³ Cabinet Office (2017) *National Risk Register of Civil Emergencies*.

²⁷⁴ Appendix A - NAP action update.

- The UK's Tick Surveillance Scheme (TSS) began in 2005. Since then it has identified 10 invasive tick species from 15 countries that have entered the UK. Tick maps are produced by PHE and from the 'Big Tick Project Survey'.²⁷⁵ Laboratory confirmed cases of Lyme disease are also recorded.
- Surveillance of invasive mosquitos takes place across UK ports and in some motorway stations and truck stops (largely focussed on south east England, where risk of mosquitos entering and establishing are greater). Native mosquito surveillance occurs across England. The European Centre for Disease Prevention and Control (ECDC) and European Food Safety Authority (EFSA) publish maps showing the distribution of mosquitos and other vectors across Europe.

There is a consensus in academic literature that the Government should strengthen and widen existing surveillance mechanisms due to the increasing risk of disease spread as a result of climate change and other factors. Surveillance expansion should model and monitor species of concern and the mechanism by which invasive species arrive in the UK, and therefore provide suitable indicators to measure vector abundance.²⁷⁶ In general, vectors and the environment are adapting continuously, so future guidelines and programmes will also need to adapt. This is often difficult to predict, but increasing surveillance and research would aid this process.²⁷⁷

The main barrier to surveillance expansion is insufficient funding for a national surveillance programme.²⁷⁸ It may be possible for surveillance of ticks and mosquitos to be 'piggy backed' onto existing systematic surveys such as the Countryside Survey or included through innovative solutions which have been shown to be successful, such as the use of social media to track disease outbreaks.²⁷⁹

Is there evidence that risk is being managed?

Increases in vector abundance are occurring, and could increase exposure to vector-borne diseases in the future.

The distribution of ticks has changed over time which may have contributed to an increased number of confirmed cases of Lyme disease (Figure 3.12). Climate change could be a cause of this change due to milder winters and warmer temperatures, however, non-climate drivers such as agriculture, land use, tourism and wild animal populations could be a more dominant influence on the incidence and distribution. Attribution of the different drivers is not yet possible.²⁸⁰

Maps from the European Centre for Disease Prevention and Control show that the Asian Tiger mosquito (*Aedes albopictus*) is introduced (without confirmed establishment) in a small area in the far south east of England.²⁸¹ This has been detected in 2016, 2017 and 2018 in Kent. This mosquito is an invasive species which can transmit dengue, chikungunya and zika virus.

²⁷⁵ See: <http://www.bigtickproject.co.uk/ticks-in-the-uk/uk-tick-threat-map/>

²⁷⁶ Medlock, J. M. et al. (2018) Assessment of the Public Health Threats Posed by Vector-Borne Disease in the United Kingdom (UK). *Int J Environ Res Public Health*, Vol 15.

²⁷⁷ POST (2019) *POSTNOTE, Climate Change and Vector-Borne Diseases in Humans in the UK*.

²⁷⁸ Appendix A - NAP action update.

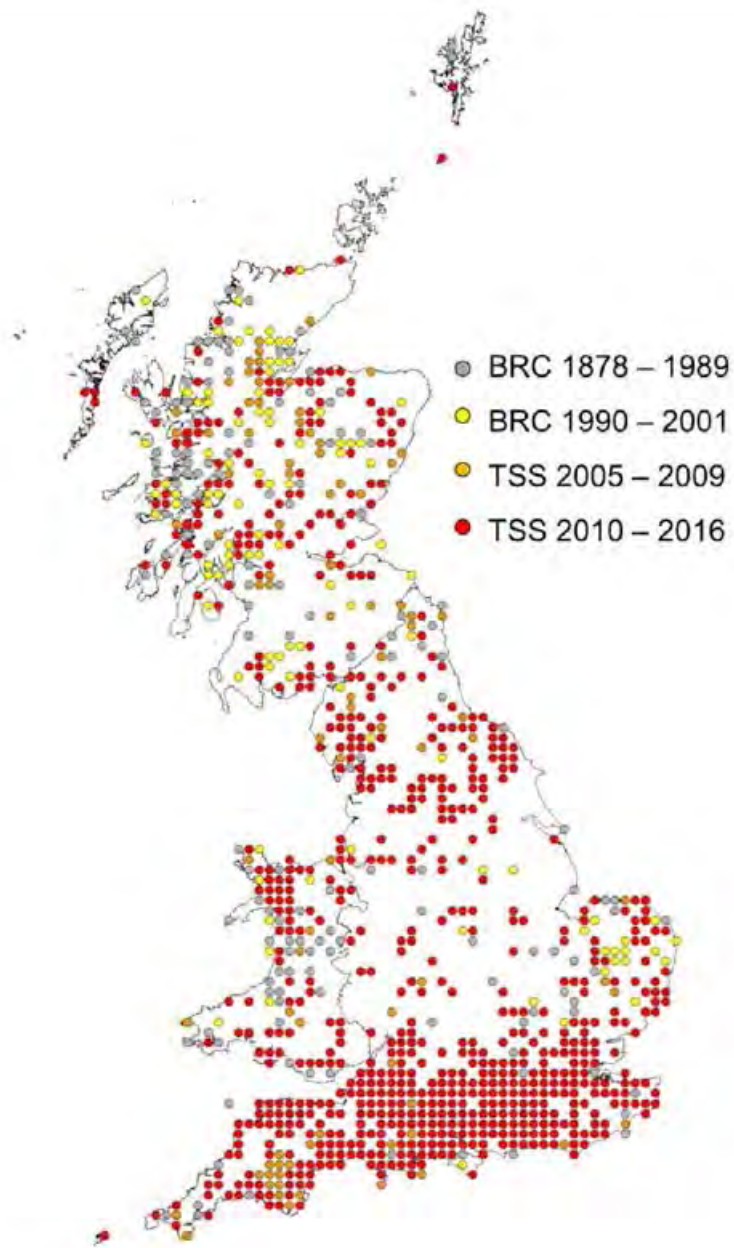
²⁷⁹ Gomide et al. (2011) *Dengue surveillance based on a computational model of spatio-temporal locality of Twitter*.

²⁸⁰ Bayliss (2017) *Potential impact of climate change on emerging vector-borne and other infections in the UK*; Kovats, R.S., and Osborn, D., (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 5, People and the Built Environment*.

²⁸¹ ADAS for the CCC (2019) *Research to provide updated indicators of climate change risks and adaptation action in England*.

The mosquito is widely established in Europe, with Italy experiencing a recent epidemic of chikungunya in 2017. The Government should ensure that the cross-government contingency plan for mosquitos includes the Asian Tiger mosquito and continue to monitor its presence.

Figure 3.12. Distribution of ticks in the UK



Source: Cull et al., (2018), as shown in ADAS for the CCC (2019) *Research to provide updated indicators of climate change risks and adaptation action in England*.

Notes: The distribution of ticks in the UK including Biological Records Centre (BRC) data for 1878-1989 and 1990-2001, and Tick Surveillance Scheme (TSS) data for 2005-2009 and 2010-2016. More recent records are overlaid on top of older records.

More research is needed to quantify the impact climate change has on these changes compared to other influential factors.

Although vector abundance is a sensible indicator of potential exposure to vector-borne disease presence or risk, other factors such as vector behaviour also influence the likelihood of disease transmission. In addition, the disease-causing microorganism (pathogen) itself has to be present and may be restricted by a range of factors. The presence of vectors, therefore, does not necessarily mean presence of diseases. More research is needed to quantify the impact of climate on vector abundance and disease presence.

Conclusion

Surveillance programmes and monitoring of vectors does occur, but there is no appropriate coordinated plan in place. More evidence is needed to understand whether climate change is impacting exposure to vector-borne diseases.

3.5.3 Air quality

What is the risk?

CCRA2 identified impacts of climate change on air quality as a research priority, with more research needed to understand the impacts of a changing climate on particulates and indoor air quality in particular.

The need for action to reduce the impacts of climate change on air pollution, when other factors are excluded, is unclear. There is an obvious need to put in place measures to reduce the effects of emissions on air pollution. Research is needed to assess how changes to climate other than increasing temperatures, such as changing wind patterns and blocking episodes, could impact on air pollution levels.

CCC progress score	Reason for progress score
3	Plan score - medium: Plans and long-term targets are in place to reduce levels of air pollution, but these do not consider the impact of climate change of future air quality levels. Regulations should be strengthened to improve indoor air quality in all homes. Risk score - low: • Research to address the CCRA2 research priority to understand future impact of climate change on air quality is postponed to 2021. • Vulnerability to air pollution, measured by the total number of people living with chronic respiratory conditions, has continued to increase. Local authorities and city regions are taking a range of actions to reduce air pollution.

Is there a good quality plan?

Are plans covered in NAP2?

NAP2 does not fully address these research gaps.

NAP2 includes an aim for Public Health England (PHE) and Department for Health and Social Care (DHSC) to review and update health research strategies by 2020 to ensure CCRA research priorities, including air quality are addressed. Despite the aim, this is not included as a NAP2 action and delivery of research has been postponed until 2021.²⁸²

NAP2 also highlights plans such as the Clean Growth Strategy and 25 Year Environment Plan which include actions to improve air quality but these also do not consider the long-term risks from climate change.

Are there other plans not mentioned in NAP2?

The Clean Air Strategy includes long-term targets to reduce levels of air pollution, but with no consideration of the impact of climate change.

A Clean Air Strategy was published in 2019 which highlights how air quality will be improved and monitored in the UK. Two types of pollutants are climate-sensitive and therefore relevant to climate change adaptation: ground level ozone and particulate matter (PM_{2.5} and PM₁₀).²⁸³ National ceiling limits and targets for 2030 for particulate matter were set in December 2016 under a new EU Directive 2016/2284/EU.²⁸⁴ Targets and limits for ground level ozone and its precursors are set under the Ambient Air Quality Directive 2008/50/EC. The provisions in this Directive are transposed into English law through the Air Quality Standards Regulations 2010.²⁸⁵ These regulations and national ceiling limits for 2030 will need to be retained in UK law when the UK leaves the EU.

The Clean Air strategy proposes new targets and actions to cut public exposure to particulate matter so that the number of people living in locations above the World Health Organisation guideline levels of 10 µg/m³ of PM_{2.5} is reduced by 50% by 2025 relative to a 2016 baseline. The strategy also includes action to reduce build-up of indoor air pollutants in homes and other buildings. The London Environment Strategy sets out the aim for London to have the best air quality of any major world city by 2050, going beyond the legal requirements to protect human health and minimise inequalities.²⁸⁶ The City of London has also published a draft air quality strategy outlining actions that will be taken to improve air quality between 2019 and 2024, although there is no consideration of potential impacts of climate change.²⁸⁷

²⁸² Discussion with PHE (2019).

²⁸³ The UK Climate Change Risk Assessment Evidence Report (2016) found that the main concern for climate change effects on health through air pollution relate to ground level ozone as it is sensitive to temperature. The impact of climate change on ambient particulate matter concentrations is more uncertain, although there is evidence that severe weather can also cause and/or exacerbate PM events. For example hot and dry conditions can increase the risk of wildfires, which can be a source of particulate matter. Wind direction may also be an important factor in the future. See: <https://uk-air.defra.gov.uk/assets/documents/reports/aqeg/pm-summary.pdf>

²⁸⁴ See: <http://ec.europa.eu/environment/air/pollutants/ceilings.html>

²⁸⁵ Defra (2016) *Air Pollution in the UK 2015*.

²⁸⁶ Greater London Authority (2018) *London Environment Strategy*.

²⁸⁷ City of London (2019) *City of London Air Quality Strategy, Draft for Consultation March 2019*.

Regulations should be strengthened to improve indoor air quality in all homes.

The CCC's 2019 housing report concluded that building regulations for ventilation must be updated to keep pace with improvements in energy efficiency and to deliver excellent levels of indoor air quality in homes. The CCC recommended that Part F of Building Regulations (for ventilation) should be reviewed alongside Part L (for energy), with a view to tightening standards and coordinating requirements to fully reflect interdependencies. This reflects the need for an integrated approach to energy efficiency, ventilation and overheating. Steps must be taken to improve the design, commission, and installation of mechanical ventilation systems, with further research into how challenges in maintaining and operating them can be overcome. Indicators to measure instances of poor indoor air quality in homes are also needed.

Do the plans address the risks in CCRA2?

Plans are in place to reduce air pollution, but they do not provide enough detail to establish if they will fully address the research priority to understand future impact of climate change on air quality.

Is progress being made in managing risk?

Are relevant actions taking place?

Local authorities and city regions are taking action to reduce air pollution.

Action is taking place to reduce levels of particulates, especially in urban areas. For example:

- Defra has set up a formal working group with the Core Cities Group to develop work on air quality and climate change resilience. This will promote adaptation in cities, and disseminate best practice and accelerate action between the Core Cities Group, London and other city region areas more widely, and deliver a programme of actions
- PHE has published a review of interventions to improve outdoor air quality and public health which can be adopted by local authorities within local plans and strategies.²⁸⁸
- The Mayor of London launched the world's first Ultra Low Emission Zone in April 2019.

Is there evidence that risk is being managed?

Vulnerability to air pollution, measured by the total number of people living with chronic respiratory conditions (COPD), has continued to increase.

Vulnerability to risks from air pollution can be monitored through assessing changes in the vulnerable population over time for air pollution related health impacts. Though asthma and COPD cases can be viewed as an impact indicator, in this context we are treating them as a vulnerability indicator; people with chronic respiratory conditions are more susceptible to periods of high air pollution:

- There has been a 6% increase in the number of patients receiving treatment for asthma in England, from 3.3 million patients in 2010-11 to 3.5 million patients in 2017-18.²⁸⁹

²⁸⁸ PHE (2019) *Review of interventions to improve outdoor air quality and public health*.

²⁸⁹ ADAS for the CCC (2019) *Research to provide updated indicators of climate change risks and adaptation action in England*.

- The number of patients receiving treatment for chronic obstructive pulmonary disease (COPD) increased by 24% from 900,000 in 2010-11 to 1.1 million in 2017-18.²⁹⁰ Over this same period, the percentage of the total population receiving treatment for COPD increased from 1.6 to 1.9%.

Conclusion

Targets are in place to reduce air pollution but there are no explicit actions in the NAP or elsewhere to improve understanding of the impact of climate change on air quality. Research to address the CCRA2 research priority to understand future impact of climate change on air quality is postponed until 2021. Actions to reduce the risks from air pollution are taking place, especially at a local level. However, vulnerability to future increases in air pollution, as measured by the number of people living with chronic respiratory diseases continues to increase.

3.6 Effectiveness of the emergency planning system

What is the risk?

CCRA2 highlights that climate change will create new challenges for those working in the emergency response sector, that may further stress the system.

These additional stresses are likely to come from increased frequency, magnitude, and concurrency of multiple climate-related events such as flooding, storms, heatwaves and droughts, that may push resources and capacity beyond what is currently available.

CCC progress score	Reason for progress score
5	Plan score - medium: There are plans in place for the major climate-related emergencies today, but these do not include consideration of the change in risk from climate change. Risk score - medium: Recent events have shown that the response system can be stretched and that capacity to respond in some areas is decreasing. These factors need to be properly assessed and addressed to ensure emergency planning is fit for the future climate.

²⁹⁰ Ibid.

Is there a good quality plan?

Are plans covered in NAP2?

NAP2 does not point to any specific plans or goals for emergency response to extreme weather events.

It does contain a limited number of actions (see below).

Are there other plans not mentioned in NAP2?

There is a framework in place for responding to climate-related emergencies and there are warning systems in place for most climate hazards. However, climate change is already altering the risk profile for some hazards. Emergency planners need to incorporate this into their plans, and Government needs to plan for the need for increased resources over the longer term.

The Civil Contingencies Act (2004) sets out clear guidelines on how to prepare for, respond to and recover from emergency events, as well as who takes responsibility for different aspects of the response. For specific types of risk, such as flooding²⁹¹, for example, this is then developed into more detailed plans for action in the event of an emergency and exercises are performed to ensure that these plans are effective.²⁹² The system for flood response was independently reviewed in 2018 and found to be adequate, with scope for improvement by spreading successful local practices more widely.²⁹³

Since 2014, the Cabinet Office has used its 'ResilienceDirect' platform to allow emergency planners and responders to develop and share information on, and plans for, emergency response and recovery in real time but we have no evidence to assess the effectiveness of this platform.

The Cabinet Office includes natural hazards, such as flooding and heatwaves, in the National Risk Assessment (NRA).

However, the first paragraph of the introduction of the public facing element of the NRA (the National Risk Register (NRR)) states that²⁹⁴ 'we are fortunate that our environment and climate are relatively calm and stable' which highlights a potentially worrying assumption about recent and projected changes in the climate extremes that drive environmental hazards. The Cabinet Office needs to ensure that the trends in the environmental hazards information supplied to them from Defra are recognised and incorporated into the NRA process. This problem is related, in part, to a mismatch in the timescales considered by the NRA and the CCRA, and this needs to be resolved so that changing environmental risks are assessed appropriately.

Do the plans address the risks in CCRA2?

These plans do not explicitly address the CCRA2 risks.

The NRR discusses how climate change may increase the probability or severity of events such as flooding but that it does not constitute a civil emergency in itself. As noted above, it is unclear how well the changing frequency and severity of natural hazards linked to climate change is incorporated into the NRA and NRR.

²⁹¹ Defra (2014) *The National Flood Emergency Framework for England*.

²⁹² <https://www.gov.uk/government/news/major-flood-exercise-from-the-source-of-the-trent-to-the-humber>

²⁹³ Cross (2018) *Multi-Agency Flood Plan (MAFP) review*.

²⁹⁴ Cabinet Office (2017) *National Risk Register of Civil Emergencies*.

Is progress being made in managing risk?

Are relevant actions taking place?

The two NAP2 actions under the 'Emergency services, local responders and community resilience' heading point to continued communication with responders and support for the development and implementation of community resilience policy.²⁹⁵

These are worthwhile actions but do not make progress towards assessing the scale of the issue in the medium- to long-term and what needs to be done to ensure that the necessary resources are available for projected longer and larger scale events and potentially more demanding emergency responses in the future.

There are well-developed warning systems in place to alert the public and emergency responders to imminent threats of flooding, heavy rainfall, strong winds and heatwaves (see Section 3.5.1).

The Met Office, Environment Agency, Flood Forecasting Centre (a Met Office/Environment Agency partnership; see Section 3.2.6) and Public Health England are all active in producing and communicating warnings across many channels. There are ongoing research efforts to improve the quality of forecasts and the effectiveness of their communication.²⁹⁶

Is there evidence that risk is being managed?

Emergency responders have coped with recent incidents but the need for increased capacity to respond to more frequent and/or greater impact from climate-related emergencies has not been assessed.

Whilst risk is increasing, the capacity to respond to incidents is decreasing. In the face of a changing risk profile²⁹⁷ and already stretched resources, the key area of vulnerability relates to whether the available response capacity could be overwhelmed by a future unprecedented event or series of events in parallel or quick succession. Category 1 responders are decreasing in number from their high point in 2009/10: the fire service has decreased in size by 19% since 2009²⁹⁸; and the police service has reduced by 18% since its peak in 2010.²⁹⁹ This impacts the emergency services' ability to respond to any major situation, including floods or heatwaves (see Section 3.5.1). Whilst the Ambulance Service increased by 7% between 2010/11 and 2015/16,³⁰⁰ it is significantly smaller than the fire and police services. The armed forces have been used to support the response to natural disasters, for example, in the Lancaster floods in 2015 when army trucks were used in place of ambulances³⁰¹ but it is uncertain if this is sustainable if their deployment rate increases. A recent review of multi-agency flood responses in England³⁰² recommended increased use of the military so an analysis of their capacity to be involved more formally is required.

²⁹⁵ NAP action update – appendix A.

²⁹⁶ See, for example, recent projects funded by the Natural Environment Research Council (NERC) under the Science Classification "weather forecasting" or "storm risk", for example, at <http://gotw.nerc.ac.uk>

²⁹⁷ CCC (2016) *UK Climate Change 2017 Risk Assessment: Evidence Report*.

²⁹⁸ <https://www.gov.uk/government/statistical-data-sets/fire-statistics-data-tables>

²⁹⁹ Home Office (2018) *Police Workforce, England and Wales, 31 March 2018*.

³⁰⁰ NAO (2017) *NHS Ambulance Services*.

³⁰¹ <https://www.theguardian.com/environment/2015/dec/06/flooding-power-cuts-lancaster-army-trucks-ambulances>

³⁰² Cross (2018) *Multi-Agency Flood Plan (MAFP) review*.

Specifically for flood responses, the number of Environment Agency staff who are trained and ready to respond to incidents is just above the target of 6,500 (6,507) but has been falling since Quarter 3 of 2017/18 (Figure 3.13).

Survey results also show that the percentage of trained staff that feel confident in their response role has dropped from 74% in 2016/17 to 69% now.³⁰³

Figure 3.13. Environment Agency staff trained to respond to flood incidents



Source: Environment Agency corporate scorecard.

In terms of equipment, there are examples of resources being stretched.

During the 2014 Somerset floods, the two pumps used were rented from the Netherlands to deal with the flooding.³⁰⁴ Seventy-five portable diesel-powered generators had to be deployed during the Lancaster floods of 2015 to restore power to the 61,000 homes cut-off from the electricity supply³⁰⁵.

These examples of stretched resources indicate the need for a thorough assessment of the equipment required to respond to similar magnitude, larger or even concurrent/serial events in the future. There is a need to determine the capacity required to respond to plausible worse-case-scenarios and develop plans to ensure that these resources can be found in the event of such emergencies.

³⁰³ <https://www.gov.uk/government/collections/environment-agency-corporate-scorecard>

³⁰⁴ <https://www.bbc.co.uk/news/uk-england-somerset-26167818>

³⁰⁵ RAEng (2016) *Living without electricity*.

Overall, the system is stretched.

The 2018 review of multi-agency flood response³⁰⁶ concluded that the system has issues for all scales of events: local resilience forums (LRFs) would struggle to respond to any very large flood event (i.e. 10,000s properties flooded); significant assistance would be required to respond to large flood events (i.e. 1,000s properties flooded); and local response could even be overwhelmed by rapid onset small-medium events (10-100s properties flooded).

Conclusion

Planning for civil emergencies is well-developed but the way that the additional risk level due to climate change is incorporated into those plans, particularly in terms of the background resource availability, needs further attention.

³⁰⁶ Cross (2018) *Multi-Agency Flood Plan (MAFP) review*.

Chapter 4: Infrastructure



4.1 Introduction

Infrastructure systems are vulnerable to failure and disruption from severe weather, as well as degradation and reduced performance resulting from long-term changes in average climate. Infrastructure is increasingly interconnected such that failures of one asset can propagate across the wider sector and impact upon other sectors. Furthermore, infrastructure assets can have very long lifetimes, in excess of 100 years. Adaptation planning that considers long-term changes in the context of 2°C and 4°C global temperature scenarios is therefore particularly important for infrastructure planning.

The CCRA highlights increasing risks to infrastructure from high temperatures, flooding, drought and coastal erosion in the coming decades. An increasing frequency and severity of flooding from a range of sources represents the most significant climate change risk to UK infrastructure. Changes in temperature and seasonal rainfall will place additional pressures on infrastructure, in particular the rail, road and water and energy sectors. Whilst understanding of sectoral risks has improved over the last few years, the impacts of climate change could be amplified by interdependencies between infrastructure sectors, and these interactions are not well understood.

Infrastructure can be built from the outset to be resilient to the anticipated range of future climatic conditions, or designed to allow it to be upgraded cost-effectively as the climate changes, i.e. a managed adaptive approach. Traditional grey infrastructure has clearer design standards and asset life but is difficult and costly to adapt to changes in demand or climate. Natural capital (e.g. green and blue) infrastructure can bring a host of multi-benefits such as flood risk management, urban cooling, supporting biodiversity, health benefits and amenity value.³⁰⁷ Natural capital assets and services are covered in chapter 2 and in chapter 3 (in the context of green infrastructure for cooling).

The National Infrastructure Commission (NIC) published its first National Infrastructure Assessment in 2018, an in-depth assessment of the UK's major infrastructure needs over the next 30 years. It made a number of recommendations to Government related to climate change, including putting in place a long-term strategy to deliver a nationwide standard of flood resilience by 2050 (see chapter 3) and ensuring that plans are in place in the water sector to deliver additional demand reductions and supply by 2050. The NIC is currently undertaking a more in-depth study on resilience to consider what other measures are needed to ensure that all assets are prepared appropriately for the future, including for climate change.

The Committee reviewed the second round of Adaptation Reporting Power (ARP) reports and found the voluntary approach taken by Defra to be ineffective in several respects.³⁰⁸ The ARP process can yield important evidence that would not otherwise be available; information which is of value to the Government, to Parliament, and the CCC. The process of producing the reports and the insights they generate are of significant value to the organisations themselves, to other reporters, and to other relevant organisations such as regulators. The reports in the second round demonstrate that effort has been invested in assessing risks and in taking appropriate adaptation actions, although the extent of this varies across organisations and sectors with many reports too vague and high level to provide insight into adaptation progress.

³⁰⁷ Demuzere, M., et al. (2014) Mitigating and adapting to climate change: Multi-functional and multi-scale assessment of green urban infrastructure. *Journal of environmental management*, 146, 107-115.

³⁰⁸ CCC (2017) *Adaptation Reporting Power: second round review*.

Not all organisations took part in the second round leading to significant gaps in coverage and it was not clear whether those that decided not to report have the greater or lesser adaptation challenges. The Committee strongly recommended a mandatory approach for ARP3, which has not been taken up.

In the sections below we assess progress being made in accounting for and adapting to climate change for new infrastructure, existing infrastructure (broken down by sector) and with regard to infrastructure interdependencies.

4.2 Design and location of new infrastructure

What is the risk?

CCRA2 covers the design and location of new infrastructure within sector specific discussions. It identifies the need to account for climate change within designs and plans:

- More action is needed to ensure increased risk of flooding is accounted for in design and location of new infrastructure.
- Energy infrastructure should be sited appropriately for managing future drought and low-river flows.
- New policies are needed to deliver more ambitious reductions in water consumption and establish strategic planning of new water-supply infrastructure.
- Transport infrastructure will need to evolve to meet the needs of the growing population, particular in densely populated regions, and also support the UK's transition towards a net-zero carbon economy.³⁰⁹ As such there are opportunities to design and maintain new transport infrastructure for a broader range of climate conditions, thus improving resilience in the sector. A pertinent example of this opportunity is that High Speed Rail 2 has been designed to have a high level of climate resilience.

³⁰⁹ CCC (2019) *Net Zero - The UK's contribution to stopping global warming*.

CCC progress score	Reason for progress score
6	Plan score - high: The National Infrastructure Assessment (NIA) 2018 set out UK's infrastructure needs for the next 30 years. It includes consideration of what new flood and water supply infrastructure is needed between now and 2050, taking into account both 2°C and 4°C scenarios. National Policy Statements are in place which require climate change projections to be taken into account when developing new major infrastructure assets and projects. They include broad consideration of 2°C and 4°C scenarios. Nationally Significant Infrastructure Projects are continuing to take account of flooding. It is more difficult to establish if other climate hazards are also being taken into account. Risk score - low: There are no new actions in the second National Adaptation Programme (NAP2) for this priority and based on the evidence available, we cannot assess how well the risk is being managed at present.

Is there a good quality plan?

Are plans covered in NAP2?

NAP2 includes the ambition to make sure that all policies, programmes and investment decisions take account of the possible extent of climate change this century, in line with the Government's 25 Year Environment Plan.

The 25 Year Environment Plan sets out that the Government need to ensure that infrastructure is located, planned, designed and maintained to be resilient to climate change. However, it does not set out how this will be achieved for new infrastructure, or any associated outcomes or actions.

NAP2 points to the National infrastructure Commission's National Infrastructure Assessment (NIA), which sets out a vision for UK infrastructure over the next 30 years. The NIA takes account of climate change in terms of flooding and water. However, the plan still needs to be agreed by Government.

The assessment includes chapters on drought and flooding resilience, alongside a separate report on England's water infrastructure needs (see section 3.2.1 for analysis of flood defence investment needs and section 4.4 on water supply).³¹⁰ The NIA and water assessment both consider the impact of different climate scenarios to 2050 based around a 2°C increase in global mean temperature by 2100. The Commission undertook similar analysis for a climate scenario based around 4°C but found that costs and benefits for a flooding standard would be much higher, and suggested taking an 'adaptive management' approach, allowing infrastructure to be upgraded cost-effectively as the climate changes.

³¹⁰ NIC (2018) *Preparing for a drier future, England's water infrastructure needs*.

The Government plans to respond formally to the NIA in 2019, when it publishes its National Infrastructure Strategy. An interim response to the NIA shows areas where the Government has already agreed with the NIC's approach, for example taking a twin-track approach to water supply and demand and increased funding for flood defences.³¹¹

Are there are other plans not mentioned in NAP2?

National Policy Statements are in place which require climate change projections to be taken into account when developing new major infrastructure projects.

National Policy Statements (NPS) cover energy, transport, water, and waste water sectors.³¹² The statements specify that designs for new infrastructure must make use of the latest climate projections over the lifetime of assets. For safety critical elements they specify that a high emissions scenario (which includes within it a 4°C rise in global temperature above pre-industrial levels by 2100) should always be used. They also state that adaptation measures should be based on the latest climate projections and the latest Climate Change Risk Assessment. Since 2017:

- A NPS for airports has been published and requires that flood risk and other climate change risks (e.g. surface water runoff and water supply) are included in development applications. The NPS is the framework for potential expansion at Heathrow Airport.
- A consultation on a draft NPS for Water Resources is completed with proposals to amend the definition of nationally significant water infrastructure and accelerate the process of providing development consent where necessary.

The National Planning Policy Framework (NPPF) is used as the framework to develop Local Plans. Planning Guidance stipulates that climate change must be taken into account but does not specify specific scenarios or outcomes.

Local Plans set out the strategic priorities for development of an area and cover housing, commercial, public and private development, and infrastructure. Local Plans are required to take account of the NPPF. Planning Practice Guidance which sits alongside the NPPF says that planning developments should apply a sequential test for flooding which specifies that developments should be safe for their lifetime, taking into account the impact of climate change. This includes:³¹³

- In Flood Zone 3a that essential infrastructure³¹⁴ should be designed and constructed to remain operational and safe in times of flood.
- In Flood Zone 3b (functional floodplain), essential infrastructure that has to be there and has passed the Exception Test, should be designed and constructed to:
 - remain operational and safe for users in times of flood;

³¹¹ HM Treasury (2018) *Interim Response to the National Infrastructure Assessment Budget 2018*.

³¹² See: <https://infrastructure.planninginspectorate.gov.uk/legislation-and-advice/national-policy-statements/>

³¹³ See: <https://www.gov.uk/guidance/flood-risk-and-coastal-change>

³¹⁴ Essential infrastructure is classified as: transport infrastructure (including mass evacuation routes) which has to cross the area a risk; utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood; wind turbines.

- result in no net loss of floodplain storage; and
- not impede water flows and not increase flood risk elsewhere.

Do the plans address the risks in CCRA2?

The National Policy Statements are the main driver for the design and location of significant infrastructure projects to take account of climate change.

NPSs must take account of high emissions scenarios and the NIA set out strategic plans for new water-supply infrastructure.

However, for smaller projects the NPPF and Planning Guidance do not ensure that climate risks, other than flooding are taken account of in new infrastructure.

Is progress being made in managing risk?

Are relevant actions taking place?

There are no specific actions in NAP2 for this priority.

The most relevant goal is that climate-proofing of all investment decisions in NAP2 is devolved to the Council for Sustainable Business (CSB) and the work of the Green Finance Taskforce.

There is no consideration related to this goal of different climate change scenarios. The 25 YEP outcome will be much more difficult to deliver under a 4°C pathway compared to a 2°C pathway, because the challenges become significantly larger.³¹⁵ It has been estimated that the indicative total adaptation cost of building climate resilience in the UK's current infrastructure project pipeline would be between £2.1 to £42 billion (primarily over the period to 2021), with an annual cost of £0.2 to £4.8 billion – the large range shows the large span of uncertainty.³¹⁶ However, there is very little existing evidence that quantifies the benefits of these measures in order to assess cost-effectiveness.

Nationally Significant Infrastructure Projects continue to take account of flooding, although it is more difficult to establish if other climate hazards are also being addressed.

Since our previous report in 2017 there have been 18 new Nationally Significant Infrastructure Projects (NSIPs) listed on the Planning Inspectorate Portal,³¹⁷ with a total of four being granted permission in England. In the context of flooding, the evidence available suggests that this is being assessed consistently in planning applications for NSIPs:³¹⁸

- no new NSIPs in England were granted planning permission with outstanding objections from the Environment Agency;
- all of those approved contained details of a Flood Risk Assessment (FRA), and the Environment Agency either made no mention of concerns with the FRA or explicitly said it was satisfied with the method, scope and findings for river and coastal flooding;

³¹⁵ Watkiss, P., Cimato, F., Hunt, A. and Moxey, A. for the CCC (2019). *The Impacts of Climate Change on Meeting Government Outcomes in England*.

³¹⁶ *Ibid.*

³¹⁷ See: <https://infrastructure.planninginspectorate.gov.uk/>

³¹⁸ See: <https://infrastructure.planninginspectorate.gov.uk/projects/register-of-applications/>

- evidence of the sequential and exception tests being applied was provided by all applications where it was required;³¹⁹
- two of the four explicitly contained Sustainable Urban Drainage Systems (SuDS) within plans.

The Environment Agency has a role to scrutinise planning applications for both minor and significant infrastructure projects to check how they have taken account of flood risk, but this is not the case for other hazards where there is no equivalent scrutiny.

Is there evidence that risk is being managed?

It is likely that at least present-day flood risk is being managed in line with Environment Agency advice, but this does not mean future flood risk is, especially for non-significant infrastructure projects.

As set out in section 3.2.3, new developments in the floodplain that are currently protected by flood defences may not be subject to an Environment Agency objection because of the existing level of protection. However, areas could flood if defences fail, are breached/overtopped or are not maintained in the long-term.

Conclusion

There is evidence of good quality plans which have accounted for climate change in the assessment of the UK's infrastructure needs, and climate change is taken into account in new nationally significant infrastructure projects. There is evidence that risk is being managed for present day flooding especially for larger infrastructure projects, although without better indicators it is unclear if risk is being managed for other climate hazards and new smaller infrastructure projects.

4.3 Energy generation, transmission and distribution

What is the risk?

CCRA2 identified risks from wind and lightning as urgent to address for the energy sector.

CCRA2 identified a need for further modelling of the risk of increased tree-related interruptions to energy supply, due to potential increased vegetation growth rates in the future with warmer summers and longer growing seasons. There is a need for better understanding of projected changes in maximum wind speeds and the frequency of such events. If maximum wind speeds were to increase, there would need to be a corresponding modification to the strength design of overhead electricity lines, poles and pylons. It is not clear whether adequate action is being taken to improve resilience to the projected increase in faults to the electricity distribution network caused by lightning strikes.

Further research is needed to understand whether the climate risks to existing and planned offshore renewable energy infrastructure, as well of the impacts of extremes on other marine technologies (i.e. wave and tidal) have been included into designs effectively.

³¹⁹ The Sequential Test ensures that the location of a new development is steered toward areas with the lowest probability of flooding. A planning authority should demonstrate, through evidence, that it has considered a range of options in the site allocation process, using the Strategic Flood Risk Assessment to apply the Sequential Test. If the Sequential Test demonstrates that there is no reasonable alternative site for a project in Flood Zones 1 or 2, a project can be located in Flood Zone 3 subject to an Exception Test.

National Marine Planning policies require offshore infrastructure to be resilient to climate change, and these policies need to be strongly implemented through the regulatory processes.

CCRA identified the risks to hydroelectric generation from low or high river flows as a ‘watching brief’ i.e. that further monitoring of the risk is required, but there is not at present an adaptation deficit (see chapter 1).

CCRA concluded there is not likely to be a significant adaptation shortfall in the next five years (2018 – 2022) as impacts of increased or reduced hydropower generation can be managed using normal operation procedures on the national grid.

CCRA2 identified flooding as a major risk to infrastructure but noted that the energy sector has a good system in place for managing flood risk.

The electricity transmission and distribution sector has developed cross-industry technical standards (see section below) for managing current and future flood risks to the network.

CCC progress score	Reason for progress score
8	Plan score - high: The electricity sector has a well-developed understanding of risks faced by flooding. Design guidelines for energy companies include climate change and require companies to protect primary substations against flooding. Plans to manage risks to nuclear infrastructure include consideration of all relevant hazards. Risk score - medium: • Flood protection measures are therefore being implemented by electricity supply, transmission and distribution companies. Over 90% of sub-stations (550/589) deemed at risk of flooding should be resilient to a 1/1000 year flood event by 2021, reducing the exposure of customers at risk of interrupted supply. • For other hazards and non-primary substations it is less clear what steps are being taken. NAP2 and the ARP2 reports have however highlighted actions and research needed to address CCRA2 gaps such as potential changes to wind speeds and the risk to gas networks crossing bridges.

Is there a good quality plan?

Are plans covered in NAP2?

A number of CCRA2 risks are discussed in NAP2 for example National Policy Statements and regulations for nuclear energy which take account of climate change.

The Department for Business, Energy and Industrial Strategy (BEIS) continues to monitor progress made by the electricity network companies on the implementation of their flood resilience programme. Where flood defences are not yet built, all sites have been surveyed for suitability for temporary defences.

Electricity network operators have a statutory requirement to keep overhead power lines clear of vegetation for public safety reasons. This is not viewed by Government as a current research priority in view of the maturity of the electricity sector's programmes to manage vegetation growth.³²⁰ The Energy Networks Association (ENA) produced an Engineering Technical Report (ETR136) in 2007 to guide vegetation management.³²¹ The standard requires operators to deliver proactive tree cutting and felling programmes targeted towards critical overhead lines, to improve performance in storm conditions. However, it is not clear if these take account of climate change.

For nuclear installations including operating reactors, the Office of Nuclear Regulation's (ONR) Safety Assessment Principles underpin the regulatory oversight and scrutiny of licensees' safety submissions throughout the lifecycle of the installation. The submissions must reflect internal and external hazards including the reasonably foreseeable effects of climate change over the lifetime of the facility as well as other factors such as coastal erosion, extreme weather and flooding.

The Energy National Policy Statements require applications for consent for new offshore renewable developments to take into account the potential impacts of climate change using the latest UK Climate Projections (both 2°C and 4°C scenarios) to ensure they have identified appropriate mitigation or adaptation measures.

Are there are other plans not mentioned in NAP2?

Electricity and gas network performance, including outages related to weather, is regulated by Ofgem. Energy companies are penalised if they fail to meet interruption targets.

Ofgem's performance standard for gas and electricity companies incentivises investment in safe and reliable services. The Interruption Incentive Scheme sets targets for the frequency and duration of both planned and unplanned, including weather-related, interruptions. Distribution Network Operators are rewarded if they meet or exceed these targets and are penalised if they fail to meet them.³²²

Standards provide a consistent approach across the industry to identify the most critical assets at the highest level of risk, accounting for climate change.

ETR138 are the design guidelines and standards that provide a consistent approach across the industry to identify the most critical assets at the highest level of risk in order to prioritise action. The revised guidelines state that primary substations with over 10,000 connections should be defended against 1/1000-year flood events (in line with the National Flood Resilience Review requirements), including surface water flooding. The Electricity sector are in the process of implementing the changes in ETR138 to their flood defence programs. ETR138 includes an assessment of the risks from flooding to all new and existing sites; it uses a 20% uplift calculation to current flood depth to take into account future climate change, but it is not clear how this relates to risks in a future 2°C and 4°C world.³²³

³²⁰ Defra (2018) *National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting*.

³²¹ Energy Networks Association (2007) *Vegetation Management near electricity equipment – Principles of good practice*.

³²² Ofgem (2017) *RII-ED1 Annual Report 2015-16*.

³²³ ETR138 says that Network Operator's should use the latest information available from the responsible agencies. The period chosen for climate impacts should match the planned lifetime of the assets being protected. Until

ETR138 also requires longer-term planning for improving permanently the resilience of service provision to sites supplying significant local communities from the flooding defined by the Environment Agency's Extreme Flood Outlines (a 1 in a 1000 year flood risk).

Do the plans address the risks in CCRA2?

The plans mostly address the risks identified in CCRA2 for flooding, at least for primary electricity substations and nuclear. For other hazards and assets it is not clear what standard of planning is in place.

It is also not clear whether adequate plans are in place to manage the risks from wind or lightning, including long-term changes due to climate change, although, research is tackling some of these gaps (see below).

Is progress being made in managing risk?

Are relevant actions taking place?

NAP2 contains relevant actions that are on-track or completed:

- Flood protection measures are being implemented by electricity supply, transmission and distribution companies over the coming decade (as highlighted above).
- Electricity network companies have continued to manage surface water flooding. Funding for this work is obtained by the downstream gas and electricity sectors through the RIIO (Revenue = Incentives + Innovation + Outputs) price control. Surface water is now included within ETR138. The industry provides regular updates to BEIS, detailing its progress on addressing risks from surface water flooding.
- Work is ongoing to improve understanding of the risk to gas networks crossing bridges. Gas networks are more resilient to climate hazards than other energy infrastructure as most are located underground. CCRA2 identified risks from subsidence as a watching brief where changes in temperature and rainfall patterns should be monitored to update assessments of risk where needed. Work is underway between BEIS and the Environment Agency to improve understanding of the risks from high river flows to gas networks and the bridges they cross.³²⁴

ARP reports highlight further actions and research to address CCRA2 gaps such as potential changes to wind speeds.

National Grid's second ARP report highlighted a number of research projects to improve understanding of impacts of climate change on electricity infrastructure:

- As part of the Resilient Electricity Networks for Great Britain (RESNET) consortium, researchers from the University of Manchester and Newcastle University have developed models that combine climate change projections with information about the National Grid to assess its long term resilience.^{325, 326}

guidance is updated, Network Operator's should use an assumption of an additional 20% on the predicted flood depth, to allow for climate change impacts during the planned lifetime of the assets.

³²⁴ Appendix A - NAP action update.

³²⁵ Fu G, Wilkinson S, Dawson RJ, Fowler HJ, Kilsby C, Panteli M, Mancarella P (2017) Integrated Approach to Assess the Resilience of Future Electricity Infrastructure Networks to Climate Hazards. *IEEE Systems Journal*.

³²⁶ Panteli M, Mancarella P, Pickering C, Wilkinson S, Dawson RJ (2017) Power System Resilience to Extreme Weather: Fragility Modelling, Probabilistic Impact Assessment, and Adaptation Measures. *IEEE Power Systems*.

- The Electricity Networks Association are currently engaged in further work with Newcastle University to assess potential changes to wind speeds as result of climate impacts and the risks this could present for electricity networks and their assets.

Is there evidence that risk is being managed?

Flood protection measures are being implemented that should reduce the exposure of customers at risk of interrupted supply.

Following the National Flood Resilience Review and ETR138, work is ongoing to ensure that over 90% of electricity sub stations (550/589) deemed at risk of flooding are 'resilient' to a 1/1000 year flood event by 2021. This equates to £100 million of expenditure on flood defences. It is less clear what steps are being taken to ensure secondary sub-stations are resilient.

CCRA2 found that current levels of investment in site protection of energy infrastructure should manage risk for most of this century under a 2°C scenario, however the number of assets at high risk (1-in-75 annual risk level or greater) increases by the 2080s under a 4°C scenario.

Conclusion

Plans and standards for flooding are good quality, and account for climate change. Actions are taking place and flood risk is being managed for primary sub-stations. It is not clear what plans exist to manage risks from projected future high winds and lightning and to non-primary substations. There is evidence of flood protection measures being implemented and research taking place to address knowledge gaps such as impact of potential changes to wind speeds and the risk to gas networks crossing bridges.

4.4 Public water supply infrastructure

Water is discussed in several chapters of this report:

- Water in the natural environment is discussed in Chapter 2: Natural environment.
- Use of water by households is discussed in Chapter 3: People and the built environment.
- Use of water by businesses and industry is discussed in Chapter 5: Business.

This section discusses supply-side measures and structural improvements to water company networks to reduce leakage, and be more resilient to severe weather.

What is the risk?

CCRA2 found that, depending on the extent of climate change and population growth, the demand for water in England is projected to exceed supply by between 1,100 to 3,100 mega litres of water per day (Ml/d) by the 2050s and 1,800 to 5,700 by the 2080s.

A package of adaptation measures, including reducing per capita consumption to 92 litres per head per day (l/h/d) and leakage by approximately 70% by 2050, was found to significantly but not fully alleviate the projected deficits under a medium climate change (between a 2.5 – 4°C global temperature rise by 2100 depending on the probability level used)³²⁷ and high population scenario.

³²⁷ Murphy, J.M., et al. (2009), *UK Climate Projections Science Report: Climate change projections*. Met Office Hadley Centre, Exeter. Page 121.

While recognising the significant action already taking place, CCRA2 identified an urgent need for longer-term water resource planning to assess the scale of risks and consider strategic options, more co-ordinated action to ensure resilient supplies especially in times of drought, and further steps to achieve the ambitious reductions in water demand and leakage that are likely to be required. Otherwise there could be increasingly difficult trade-offs between the needs of industry, farming and the public water supply, and the ecological status of rivers, lakes, estuaries, and groundwater.

CCC progress score	Reason for progress score
8	Plan score - high: The Water Resource Management Plans (WRMPs) set out how water companies have committed to more ambitious targets to reduce leakage and many have considered possible options for new water supply infrastructure and improving resilience to extreme weather. Risk score - medium: After large reductions in leakage during the 1990s, there has been slower progress. Water companies are investing to improve resilience but it is not clear if this investment will be adequate to address future risks, particularly in the context of a 4°C global temperature scenario.

Is there a good quality plan?

Are plans covered in NAP2?

NAP2 identifies positive steps to address a broad range of risks to the resilience of public water supplies. The majority of plans, however are not clearly linked to a specific climate change scenario or level of drought and do not state the intended outcome.

NAP2 referenced the 25 YEP Goal 'to provide clean and plentiful water for future generations. To increase water supply and incentivise greater water efficiency to maintain a plentiful supply as demand increases and climate change impacts availability.' It stated that working towards achieving this goal would involve encouraging companies and individuals to take a responsible approach to water saving and reducing waste and adopting changed behaviours, in addition to strengthening the resilience of supply whilst managing demand.

In NAP2, Defra identifies several different ways in which it will work to strengthen the resilience of supply:

- It is working with water companies to improve the level of resilience against drought and will work with other sectors to understand their drought risks and how these can be mitigated. During drought the priority will be maintaining the public water supply for public health and critical national infrastructure.
- With Ofwat and the EA, it will continue to push commitments by water companies on leakage and reducing water supply interruptions and incentivise them to go further. It wants to see a year on year reduction in the volume of water lost to leakage.

- Through a Strategic Policy Statement,³²⁸ it directs Ofwat to challenge companies to assess the resilience of their system and infrastructure against the full range of hazards and threats, including flooding, and take proportionate steps to improve resilience where required.
- Government will streamline the planning process for large water infrastructure through a National Policy Statement.
- It is working with Ofwat, water companies and the EA to reduce barriers to trading water.

These represent positive steps and address a broad range of risks to the resilience of public water supplies. However, it is not clear what climate change scenario or level of drought is being used to determine the level of action in each case. With the exception of going beyond a 15% reduction in leakage, outcomes and timescales are not stated.

In addition to WRMPs, NAP2 refers to new Drainage and Wastewater Management Plans (DWMPs) which will require water companies to take a long-term view and model the impacts of climate change on their drainage and wastewater systems.

NAP2 refers to the Water Resource Management Plan (WRMP) process. As was discussed for demand management in Section 3.4.2, the WRMP process requires water companies to develop good plans for adapting to the risks of future water scarcity, including on the resilience of their supplies. Water companies are required to look at least 25 years ahead, consider their resilience to at least a severe drought (1 in 200 years) and model the impacts of climate change. In addition, NAP2 also refers to new drainage and wastewater management plans (DWMPs) (see Section 3.2.1).³²⁹ In advance of producing their business plans in 2024, the ten water and wastewater companies in England and Wales have committed to produce DWMPs, setting out how they intend to extend, improve and maintain a robust and resilient drainage and wastewater system over a minimum period of the next 25 years. As Risk Management Authorities,³³⁰ water companies must make sure their systems have the appropriate level of resilience to flooding, and can maintain essential services during emergencies. DWMPs will aim to ensure a more joined up approach with other Risk Management Authorities.

Are there are other plans not mentioned in NAP2?

Analysis by the National Infrastructure Commission suggests the total amount of additional water that new supply infrastructure, transfers and leakage reduction should provide.

The National Infrastructure Commission recommended building resilience to an extreme drought (1 in 500 years) by 2050, which requires a supply and demand reduction of at least 4,000 MI/d based on a medium emissions scenario (between a 2.5 – 4°C global temperature rise by 2100 depending on the probability level used). It also recommended that around a third of this 4,000 MI/d should be provided by each of building new supply infrastructure, leakage reduction and demand management.

³²⁸ Defra (2017) *The government's strategic priorities and objectives for Ofwat*.

³²⁹ Water UK (2018) *A framework for the production of Drainage and Wastewater Management Plans*.

³³⁰ Defra provides funding for flood risk management through grants to the Environment Agency, local authorities and internal drainage boards. These risk management authorities and others have their own responsibilities and powers that they can use in order to carry out these responsibilities. Water and sewerage companies are responsible for managing the risks of flooding from surface water and foul or combined sewer systems.

Initial analysis of the 2019 draft WRMPs shows that around 1,200MI/d will be delivered through new infrastructure, roughly in line with the NIC's recommendation.³³¹

Water companies were asked to consider resilience in their business plans including providing new performance commitments and risk-based metrics.

In addition to WRMPs, water companies produce business plans setting out their proposals for charging customers, investment and ensuring long-term resilience. Ofwat's guidance for the most recent round of plans defines resilience as 'the ability to cope with, and recover from, disruption and anticipate trends and variability, in order to maintain services for people and protect the natural environment now and in the future.'³³² It splits resilience out into different categories, the most important for adaptation to climate change is operational resilience.³³³ This is defined as "the ability of an organisation's infrastructure, and the skills to run that infrastructure, to avoid, cope with and recover from disruption in its performance." Ofwat's outcomes framework aims to get water companies to address current and future resilience challenges through performance commitments and risk-based metrics:

- Day-to-day performance commitments: forward-looking upper quartile performance for supply interruptions, sewer flooding and pollution incidents for all companies.
- Asset health performance commitments: mains bursts, unplanned outage, sewer collapses and treatment works compliance.
- Risk-based resilience metrics: new forward-looking resilience common performance commitments for resilience to drought and flooding:
 - Risk of severe restrictions in a drought: Percentage of the population the company serves that would experience severe supply restrictions (for example, standpipes or rota cuts) in a 1 in 200 year drought; and
 - Risk of sewer flooding in a storm: Percentage of population at risk of sewer flooding in a 1 in 50 year storm.
- Longer-term performance commitments and planning: companies are required to provide projections for their performance commitments out to at least 2035 to support a longer-term focus.

Ofwat reviewed draft water company business plans at the beginning of 2019. The review identified positive and negative aspects of the way that companies approached resilience.

Ofwat gave its initial assessment of water company business plans in January 2019.³³⁴ Three water companies were given 'fast-track status' meaning their plans are deemed ready to implement, whereas the other water companies were asked to do further work before re-submitting their plans to Ofwat.

³³¹ Defra (2018) *Draft National Policy Statement for Water Resources Infrastructure*.

³³² Ofwat (2017) *Delivering Water 2020: Our final methodology for the 2019 price review*.

³³³ Common definitions involve subtle differences between adaptation and resilience. Adaptation is the process of adjustment to climate effects, in order to moderate the negative and/or enhance the positive impacts of climate change. Resilience is the ability of a system to anticipate, absorb, accommodate or recover from a hazardous event. From Fankhauser, S. (2016) *Adaptation to climate change. Centre for Climate Change Economics and Policy Working Paper No. 287. Grantham Research Institute on Climate Change and the Environment Working Paper No. 255*.

³³⁴ Ofwat (2019) *PR19 initial assessment of plans: Overview of company categorisation*.

With regards to resilience, including different aspects such as financial resilience in addition to resilience to future drought and extreme weather, the review identified both good and bad practices, including low uptake of green infrastructure (see Section 3.2.5 and Section 3.5.1) which are set out in Box 4.1.

Box 4.1. Ofwat's assessment of resilience in water companies' business plans

Companies typically:

- put forward commitments to improve day-to-day resilience and engage with their customers on resilience;
- describe well-established sets of systems and processes to identify and assess risks to resilience, but it is not always clear how they prioritise and mitigate those risks;
- develop better plans to make clean water services resilient, compared to wastewater and drainage challenges;
- do not use a systems-based approach to assessing risks to resilience;
- do not show they understand how much risk there is that customers will lose services;
- consider a range of options to mitigate operational risk but need to do more to make sure they choose the best options; and
- start to consider environmental resilience but do not make enough use of nature-based solutions to improve resilience beyond catchment management schemes (preventing pollution from getting into raw water sources rather than, for example, treating the water after contamination).

Many companies' proposals on resilience are backed up with improvements in performance commitments such as reductions in supply interruptions and improvements in asset health measures.

Source: Ofwat (2019) *PR19 initial assessment of plans: Overview of company categorisation*.

For the next round of water company business plans in 2024, Ofwat, the Environment Agency and Defra should improve relevant guidance and be able to provide greater assurance about the resilience of national public water supplies in their assessments.

Ofwat's assessment shows that there are aspects of resilience which need to be improved. For aspects such as natural capital solutions or implementing sustainable drainage systems (SuDS), the guidance referenced these as something that companies should consider but did not go beyond this. When carrying out assessment of these plans, Ofwat should collate information for the sector as a whole to indicate how widely these solutions are being implemented. The guidance for the next round should highlight best practice and give companies more specific examples. This should align with improvements in the guidance for WMRPs (see Section 3.2.4) and be coherent with the NIC's recommendation to build resilience to an extreme drought (1 in 500 years) by 2050.

Across nearly all the business plans that Ofwat identified as needing further work, one factor was that costs were usually around 10 to 20% higher than Ofwat's view of efficient and justified costs. Improvements in resilience will require significant investments by water companies over the coming Asset Management Plan periods.

Ofwat and the Environment Agency will need to make use of the new national framework for water resources planning (see below) to ensure that adequate investment is made to ensure the resilience of public water supplies, and state how trade-offs with customer bills have been considered. Increased use of metrics and quantitative indicators, at both company and sector level, would provide greater assurance about the level of resilience that is being planned for.

Ofwat has identified that it needs to make a shift in bringing a longer-term perspective to its approach by setting long-term targets; planning for sustainable future water resources; and ensuring long-term operational resilience.³³⁵

Do the plans address the risks in CCRA2?

NAP2 sets out plans to consider strategic options and achieve more co-ordinated action to ensure resilient supplies in times of drought.

NAP2 identifies positive steps to address a broad range of risks to the resilience of public water supplies. In addition to further reductions in leakage, these plans have the potential to address the risk in CCRA2 but do not currently make clear the climate change scenario that is being prepared for, and also do not give corresponding outcomes and timescales. In response to guidance from Defra and Ofwat, water companies have improved how they plan for resilience in the latest round of business and water resource management plans. However, Ofwat's assessment of these plans highlighted a number of areas which need to be improved in time for the next planning period. There is an overall lack of quantitative indicators to indicate the level of resilience that will be achieved and identify how this could vary depending on how much water companies charge their customers and invest in resilience measures. Without greater assurance in these areas, plans may not adequately address the urgent need for long-term water resource planning identified by CCRA2.

Is progress being made in managing risk?

Are relevant actions taking place?

New infrastructure, including that which allows more water transfers to take place among regions, will be required to increase the supply of water to areas of scarcity. In line with NAP2 actions, Defra and the Environment Agency are carrying out work to streamline the planning process and enable greater collaboration within the water sector.

A combination of new reservoirs, transfer schemes and other infrastructure like desalination plants will be required to deliver the additional 1,300 Ml/d of new supply recommended by the NIC. Defra has published a draft National Policy Statement which aims to enable infrastructure to be constructed in time so that it will help meet the challenge of future water scarcity while also taking into account the needs of the environment and risks such as flooding.

Transferring water among regions can be an effective way to increase the supply of water in addition to using storage infrastructure.³³⁶ However, transfers currently only make up about 4% of total supply despite efforts to increase this in recent years.

³³⁵ Ofwat (2019) *Ofwat's emerging strategy: Join the conversation*.

³³⁶ Deloitte (2015) *Water trading – scope, benefits and options*; Cave, M (2009) *Independent Review of Competition and Innovation in Water Markets*; Ofwat (2010) *A study on the potential benefits of upstream markets in the water sector in England and Wales*; Ernst and Young (2011) *Changing course through water trading*.

Some of the obstacles in transferring water include: high construction and operation costs; the risk of simultaneous drought in different regions; the accidental transfer of invasive species and the uncertainty around possible losses during the transfer process.³³⁷

To support collaboration within the sector, the Environment Agency is developing a national framework for water resources in time for the 2024 round of WRMPs. The Environment Agency has commissioned specific research to identify and prioritise solutions to the barriers to collaboration between water companies and between water companies and third parties.³³⁸

Water companies are taking a range of actions to improve their security of supply and have forecasted higher levels of spending on their resilience to extreme events over the next five years.

Examples of actions taken by water companies to improve their security of supply include:

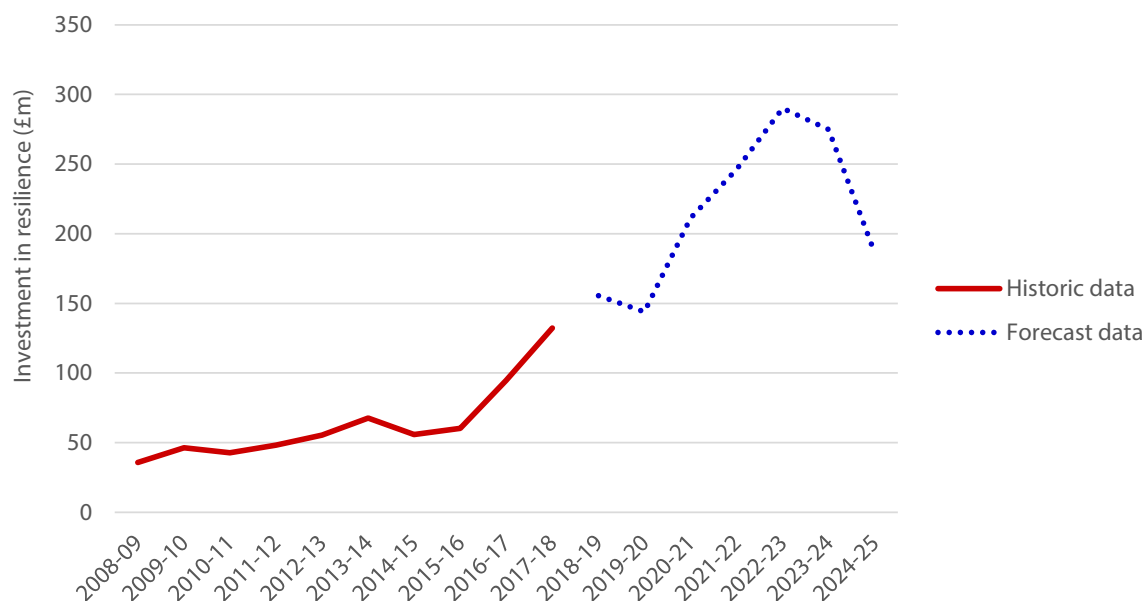
- Water efficiency campaigns and metering (see Chapter 3).
- Increased leakage detection and reduction measures.
- Drought exercises.
- Assessing interdependencies with energy generation.
- Prioritising investments in assets at high risk of flooding.
- Implementing sustainable drainage systems (SuDS).

Water companies are asked to provide annual reports of their capital expenditure to manage the risk to provision of an appropriate level of service protection for consumers in the face of extreme events caused by hazards that are beyond their control. These categories of expenditure may focus more on aspects like flood management, as they are linked to meeting the requirements of the National Flood Resilience Review. Figure 4.1 shows that spending in these categories by water companies was £132.3 million in 2017/2018, a 271% increase since 2008/2009. Looking forwards, spending is forecast to increase, peaking annually at £290 million in 2022/2023. These forecasts could change after companies submit their revised plans. It should be noted that expenditure outside of these categories may also contribute to resilience.

³³⁷ EFRA (2018) *Regulation of the water industry*.

³³⁸ <http://bidstats.uk/tenders/2018/W47/691404991>

Figure 4.1. Reported and forecast spend on resilience by water companies, 2008/2009 to 2024/2025 (£m)



Source: ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*.

Notes: Other expenditure by water companies outside of these specific categories could also contribute to resilience. For 2011/2012 to 2016/2017 these datasets contained data for spend on resilience (in £million) for water resources, raw water distribution, water treatment, treated water distribution, sewage collection, sewage treatment, total network plus, sludge transport, sludge treatment, sludge disposal and sludge total for the years between 2011/2012 and 2016/2017. These were added together to provide a total spend on resilience for each water company for 2011/2012 to 2016/2017. In the individual PR19 Business Plan data tables by each water company, actual data is provided for 2017/2018, as well as forecast investment for the period 2018/2019 to 2024/2025. Investment attributable to resilience is listed as 'A14. Enhancement expenditure by purpose – capital: Resilience'. Within these PR19 business plans, 'enhancement expenditure by purpose – capital: resilience' is defined as 'transition capital expenditure on schemes delivered in the report year to improve resilience. This relates to expenditure to manage the risk of giving consumers an appropriate level of service protection in the face of extreme events caused by hazards that are beyond their control' and 'to include expenditure to meet new, more onerous requirements stemming from the National Flood Resilience Review'.

Is there evidence that risk is being managed?

Water companies have made a new commitment to halve leakage from its present-day level by 2050 at the latest. After large reductions in leakage during the 1990s, there has been slower progress, particularly since 2011/2012 where leakage was about 150 MI/d lower than it is at present.

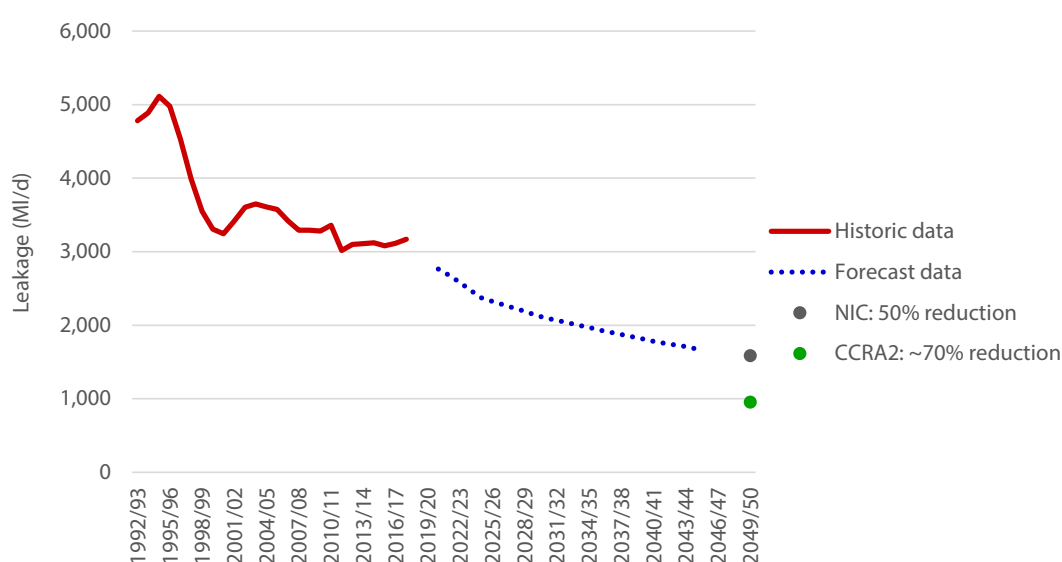
Following the NIC's report, Water UK wrote a letter to the Secretary of State confirming the sector's ambition to reduce by at least half the total amount of water lost to leaks in England, by 2050 at the latest.³³⁹

³³⁹ <https://www.water.org.uk/publication/letter-to-the-secretary-of-state-leakage/>

This is below the 70% reduction, which as part of a package of adaptation measures in CCRA2, was shown to significantly, but not fully, alleviate projected future supply-demand deficits under a high population and medium climate change (between a 2.5 – 4°C global temperature rise by 2100 depending on the probability level used) scenario.

Figure 4.2 shows that after large reductions in leakage during the 1990s, there has been slower progress, particularly since 2011/2012 where leakage was about 150 MI/d lower than it is today. This is in part due to a regulatory approach aimed at achieving the ‘sustainable economic level of leakage’, whereas to meet the new commitments companies will need to undertake a programme of sustained investment and innovation in detecting and fixing leaks. In 2017/2018 leakage was around 3,170 MI/d, a slight increase from the previous year, in part due to the impacts of the ‘Beast from the East’ and the consequent ‘freeze/thaw’ in 2018.³⁴⁰

Figure 4.2. Total leakage for all water companies from 1992/1993 to 2017/2018, with forecast data from 2020/2021 to 2044/2045



Sources: CCC analysis; ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*; Environment Agency (unpublished at time of writing); National Infrastructure Commission (2018) *Preparing for a drier future*; HR Wallingford et al. for the CCC (2015) *CCRA2: Updated Projections for Water Availability for the UK: Final Report for the Adaptation Sub-Committee*; Environment Agency (2011) *Distribution input and supply pipe leakage: 1992/93 to 2010/11*.

Notes: Forecast data are based on the latest revised draft Water Resources Management Plans (WRMPs). These forecast data may differ from those in later revised draft and final WRMPs. The National Infrastructure Commission recommended the water industry should halve leakage by 2050 to build resilience to an extreme drought (1 in 500 years) based on a medium emissions scenario. A package of adaptation measures, including reducing leakage by approximately 70% by 2050, was found to significantly but not fully alleviate the projected deficits under a medium climate change (between a 2.5 - 4°C global temperature rise by 2100 depending on the probability level used) and high population scenario. As a percentage of distribution input, leakage accounted for approximately 22% of water use in 2010/2011, the last year for which data are available, down from 29% in 1992/1993.

³⁴⁰ Defra (2018) *Water conservation report*.

Conclusion

In addition to the requirements of the Water Resource Management Plans, water companies have committed to a more ambitious target to reduce leakage and there are promising signs of new supply. Water companies are investing to improve resilience but it is not clear if this investment will be adequate to address future risks, particularly in the context of a 4°C climate change scenario.

4.5 Ports and airports

What is the risk?

Today extreme weather causes the most disruption to operations and climate change will increase this, although the risk to ports and airports is poorly understood at a national level.

Half of the UK's port capacity is located on the east coast, where the risk of damage from a tidal surge is greatest. Sea-level rise of 50cm or more by 2080 is a particular concern, especially for some ageing port infrastructure, but flooding and physical damage to harbour infrastructure will also become an increasing threat.

The impacts of climate change on UK aviation are expected to be the least significant of all transport modes. However, there is evidence of impacts from flooding, for example a number of ports were affected by the 2013 sea surge and Gatwick Airport suffered significant flooding in December 2013. The largest challenges are currently due to extreme weather. Snow and ice continue to be a problem, although this risk is expected to be reduced with climate change. Fog is a perennial problem, however projections for fog impacts with climate change are limited and of low confidence.

CCC progress score	Reason for progress score
5	Plan score - medium: Resilience standards and performance are, in general, left to individual port and airport operators to determine. Gatwick and Heathrow are required to produce resilience plans and incorporate resilience into businesses planning. For the second round of the ARP, 16 ports and airports submitted reports outlining adaptation actions, although another six declined to participate. Without making the Adaptation Reporting Power mandatory the Government has no assurance that risk is being managed completely in these sectors. Risk score - medium: - NAP2 actions are focused on better understanding of risk, rather than reporting on changes in vulnerability. Ports in general have been proactive in raising quay heights and assessing interdependencies. Actions at airports to improve flood resilience have been more reactive. - There are limited data available to assess the frequency of disruptions to port and airport operations from severe weather events, and how this might change in the future.

Is there a good quality plan?

Are plans covered in NAP2?

Plans covered in the NAP do not include outcomes or consider long-term effects of climate change.

NAP2 highlights the Department for Transport's (DfT) port connectivity study which sets out the importance of the port industry and its interdependencies with other infrastructure. The preparedness of the road and rail networks for climate change could be an important operational factor for ports in the future. However DfT's study does not consider long-term climate change.

For the second round of ARP, 16 ports and airports submitted reports, although another six declined to participate.

The reports received provided an update on adaptation actions. For the third round of ARP the CCC would like to see all airports and ports reporting to ensure full coverage. So far, ten airports and the National Air Traffic Control Services are planning to report. Seven harbour authorities are also planning to report.³⁴¹ ARP3 reports should provide climate risk assessments and set out actions taken to reduce risks where needed.

³⁴¹ See: <https://www.gov.uk/government/publications/climate-change-adaptation-reporting-third-round/list-of-organisations-reporting-under-adaptation-reporting-power-third-round#harbour-authorities-relating-to-ports>

Are there are other plans not mentioned in NAP2?

Resilience standards and performance are, in general, left to individual port and airport operators to determine. There is a move towards setting minimum standards in the 2050 Aviation Strategy.

Ports and airports are owned and operated by private-sector companies, and resilience and operations are generally left to the operators to determine based on their commercial interests.

The Civil Aviation Authority (CAA) regulates the safety of airports under the Civil Aviation Act 2012. Gatwick and Heathrow airports have economic licence conditions mandating the preparation of resilience plans and are incorporating resilience into business plans:

- Gatwick airport's capital investment programme published in 2018 includes two key areas: power and flood resilience.³⁴² Investments in flood mitigation are planned to take place between 2018/19 and 2021/22.
- Heathrow's capital business plan has a vision to provide 'A resilient airport with capability to meet demand and recover quickly'.³⁴³ One objective is to build greater resilience to adverse weather and other events.

Nevertheless, a lot of work to date has been reactive and beyond these airports the Government does not have a process to ensure other airports have adequate plans in place for potentially disruptive events. The Draft Aviation 2050 Strategy consultation proposes that Government work with the aviation industry to develop resilience (including disruptive weather and flooding) and contingency planning guidance that sets minimum standards for the industry.³⁴⁴ The Strategy mentions climate change in terms of resilience and greenhouse gas emissions but does not consider the adaptation needs for 2°C or 4°C global temperature scenarios.

Do the plans address the risks in CCRA2?

The Government has put in place the basis for reporting on climate risks in the ports and airports sectors through the Adaptation Reporting Power. However, under the current voluntary approach, not all asset owners have reported, and the way that reporting was carried out in ARP2 did not allow for an assessment by the CCC of how actions being taken are reducing risk.

Is progress being made in managing risk?

Are relevant actions taking place?

NAP2 includes only one action for ports and one for airports. These are more focused on increasing understanding of risk rather than reporting on reducing vulnerability or exposure.

Previous actions reported through the NAP and ARP have included flood mitigation work at airports and raising quay heights and understanding interdependencies at ports. More data are needed to assess the frequency of disruptions to port and airport operations from severe weather events, and analysis of how this might change in the future.

Since airports work as a network, flights or people can be diverted to other locations if a single asset is affected by severe weather (e.g. high winds) which prevents flights from landing.

³⁴² Gatwick Airport (2018) 2018 Gatwick capital investment programme.

³⁴³ Heathrow Airport (2018) Strategic Capital Business Plan.

³⁴⁴ HM Government (2018) Aviation 2050: The future of UK aviation.

Likewise, the UK's two air traffic control centres (based in Hampshire and Ayrshire) are able to cover some aspects of each other's operational functions if necessary.³⁴⁵ NATS state that they ensure that all suppliers and sub-contractors have adequate plans or contingency to manage climate change (including telecoms and IT).³⁴⁶

NAP2 specifies that:

- Flood risk will be assessed by airports with over five million passengers per year through their annual resilience plans. It highlights the formation of a voluntary Industry Resilience Group (IRG), which was established in 2018 as a collaboration between airports, airlines, air traffic control and regulators.³⁴⁷
- DfT will continue to liaise with the ports by feeding important and relevant climate risk information and evidence through groups such as the tidal surge workgroups. In terms of coastal flooding the benefits of protecting these different assets are not prioritised in the Government's coastal defence spending decisions at present.³⁴⁸

The NAP2 action for airports focuses on those with large numbers of passengers. However, some airports accommodate cargo and passenger aircraft. For example East Midlands Airport is the UK's busiest cargo airport after Heathrow. Government should ensure that actions and plans consider airports that handle a large amount of freight.

Is there evidence that risk is being managed?

There are no updated data for airports and ports available to assess vulnerability.

More information on the frequency of disruptions to operations from severe weather and climate events is needed.

Conclusion

There is no overarching plan for ports or airports to manage climate risks, although some actions have been reported through ARP. However, under the current voluntary approach, not all asset owners have reported. Ports in general have been proactive in raising quay heights and assessing interdependencies. Actions at airports to improve flood resilience have been more reactive.

4.6 Rail network

What is the risk?

CCRA2 identified a number of risks to the rail network where more action or research was needed, particularly around flooding, bridges, slope and embankment failures and wind:

- More action is needed to address flooding risks; 580 stations and 2,400km of the railway in the UK cross areas at a high risk (1-in-75 years or greater) of flooding. The number of stations is projected to increase by 10 – 28% by the 2080s, while the length of track located in areas of high risk could increase by 41 – 120%. Much of this infrastructure however will be elevated and therefore above potential flood levels.

³⁴⁵ Defra (2018) National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting.

³⁴⁶ NATS (2011) *Adaptation Reporting Power report*.

³⁴⁷ Appendix A - NAP action update.

³⁴⁸ CCC (2018) *Managing the coast in a changing climate*.

- Further action is required to ensure that projected increases in heavy rainfall events are factored into long-term renewal programmes for earthworks.
- More research is needed to identify the number of bridges at risk of scour now and in the future and the amount of adaptation underway nationally.
- There is a need for further modelling of the risk of increased tree-related faults due to increased vegetation growth rates. There is also a need for better understanding of projected changes in maximum wind speeds and the frequency of such events.
- Rail bucking events due to extreme or prolonged heat are expected to be four or five times more frequent by the 2050s. More extreme temperatures will also increase the exposure of staff and passengers (see Chapter 3). Planned levels of future activity are appropriate, but continued implementation is needed to ensure that increasing risk is managed in the future.

CCC progress score	Reason for progress score
8	Plan score - high: Weather resilience and climate change adaptation plans exist for each Network Rail route. The plans set out actions, timeframes, accountability and responsibilities in relation to implementing resilience measures under a medium emissions scenario. A climate change and weather resilience strategy is also in place. It is a good starting point for a framework to embed adaptation and resilience into policies, standards, decisions and investment. Risk score - medium: Actions relating to rail infrastructure are associated with risk reduction, and it is likely they are reducing vulnerability in some areas, but we do not have the evidence at present to show this. The main indicators available for rail reliability are delay data and although of interest, they do not give a sense of how vulnerability to climate risk is changing.

Is there a good quality plan?

Are plans covered in NAP2?

A climate change strategy is in place for Network Rail, alongside weather resilience and climate change plans for each route. Route plans contain actions whereas the climate strategy currently provides guidance to prepare for future action rather than specific measurable goals to reduce risk. However, it is a good starting point to provide a framework to embed adaptation into decisions and investments.

DfT requires Network Rail to manage the resilience of the railway network to severe weather, taking account of the impacts of climate change, and to other potential threats. Much of the rail network is over 100 years old, some of which is approaching 200 years old. Adverse weather can have a substantial impact on the network.

DfT has ultimate responsibility for ensuring that the rail network remains resilient to climate change. It relies principally on Network Rail, as the owner, operator and infrastructure manager of most of the UK rail network, to do this on its behalf. The Government provides Network Rail with funding and with guidance on its strategic priorities through five-yearly Control Periods.

In order to manage resilience of the network to severe weather and climate change, Network Rail has published a climate change and weather resilience strategy. This provides a framework within which all work relating to weather resilience and climate change adaptation is undertaken across Network Rail's routes.³⁴⁹ It is intended to integrate activities to enhance weather resilience and adapt to future climate change in policies, standards and procedures, including project development and asset management processes. Route Weather Resilience and Climate Change Adaptation Plans that set out actions, timeframes, accountability and responsibilities in relation to implementing resilience measures in Network Rail's routes are due to be updated for Control Period 6 (2019 - 2024). These plans use a medium emissions scenario 90th percentile (equivalent to a 4.2°C increase in global temperature by the end of the century), but sense check using a higher emissions scenario, especially for assets with a longer life.

In addition to track infrastructure, DfT's Key Train Requirements document encourages train operators to improve the resilience of their rolling stock.³⁵⁰ The guidance is used to inform franchise specifications and train design, and contains advice on how to ensure train performance can be maintained through the vehicles' lives in a wide range of climate conditions. It does not mention explicitly climate scenarios but does advise that the rolling stock of the future needs to be designed to provide more resilience to foreseeable extremes of heat, rainfall and cold which respond to the impact of climate change and the associated predictions of more frequent instances of extreme weather conditions.

Are there are other plans not mentioned in NAP2?

On a local level, Transport for London published the Mayor's Transport Strategy in March 2018 which demonstrates good practice in resilience planning (Box 4.2).³⁵¹

Box 4.2. London Mayor's Transport Strategy

The Mayor's Transport Strategy includes an aim to improve climate change research and evidence in London to inform a cost-effective long-term plan and programme of mitigation work. Once risks and costs have been analysed, actions will be implemented in three different ways by:

- Including adaptation measures in construction and asset renewal to provide resilience.
- Ensuring major projects are designed and future-proofed against severe weather conditions for their entire lifetime.
- Identifying high-priority locations for proactive severe weather resilience interventions.
- The strategy also includes an ambition for Transport for London to help improve and drive opportunities for green infrastructure.

Source: Mayor of London (2018) *Mayor's Transport Strategy*.

³⁴⁹ Network Rail (2017) *Weather Resilience and Climate Change Adaptation Strategy 2017-2019*.

³⁵⁰ Rail Delivery Group (2018 update) *Key Train Requirements – Issue 5 draft*.

³⁵¹ Mayor of London (2018) *Mayors Transport Strategy*.

Do the plans address the risks in CCRA2?

Plans cover risks identified in the CCRA, including actions around flood risk management, a programme of bridge scour protection, earthworks renewals, refurbishments and maintenance, effective lineside management of vegetation and consideration of changes in growing seasons. In addition plans aim to ensure that policy procedures and standards consider future weather conditions appropriately so that climate change is addressed within all work and investments.

Is progress being made managing vulnerability?

Are relevant actions taking place?

Actions in NAP2 relating to rail infrastructure are associated with risk reduction, and it is likely they are reducing vulnerability in some areas. However, without better indicators available it is hard to assess their impact. Actions are focussed particularly around flood risk, slope stability and bridges.

The first NAP outlined the vulnerability of certain parts of the transport network and set out DfT's embedded measures to mitigate climate risks within rail strategies. DfT is continuing to work with the sectors to increase resilience in planning and design of new and upgraded infrastructure. For example:

- The Tomorrow's Railway and Climate Change Adaptation (TRaCCA) project, led by the Rail Safety and Standards Board (RSSB), is now complete and has made a number of recommendations to Government in their Executive Report.³⁵²
- The project's aim was to enhance and disseminate knowledge within the GB railway industry about how climate and weather are projected to change in the future, the potential impact on the GB railway, what is currently being done and what else can be done. Recommendations include a better understanding of future risks, developing guidance to prioritise adaptation actions, creating asset function strategies and plans and reviewing asset policies and standards to include climate change consideration.

Network Rail is undertaking further adaptation actions beyond those set out in NAP2 and alongside updating weather resilience and climate change route plans:

- New infrastructure projects are required to consider climate change risk in the development of design options.
- Guidance, data and tools for understanding and managing climate change impacts are available/being developed to support embedding adaptation requirements within business as usual activities across the company. This includes updating climate change projection guidance using UKCP18.
- Asset teams are undertaking climate change risk assessments and developing strategies and action plans from an asset management perspective which will lead to updated design, operation and maintenance standards. Results will feed into CCRA3 and ARP3 reports.
- Research projects to assess which assets are most vulnerable and prioritise action, and to improve understanding of the real cost of weather resilience and climate change adaptation.

³⁵² RSSB (2016) *Tomorrow's Railway and Climate Change Project Executive Report*.

- Planning work to develop resilience metrics and understand interdependencies within Network Rail and wider UK infrastructure systems.

Is there evidence that risk is being managed?

The main indicators available for rail reliability is delay data and although of interest, as an impact indicator it does not provide a reliable trend of how vulnerability to climate risk is changing.

Rail incidents due to severe weather have fluctuated over the years:

- There were 37,820 weather related incidents in England between 2006/07 and 2017/18, of which wind accounted for 31% of incidents, and snow 23%.³⁵³
- The total number of minutes delay due to weather incidents were greatest in 2013/14 when over two million minutes delay were recorded. Wind incidents accounted for 54% of this delay time. 2011/12 had the lowest number of minutes delay due to weather incidents, followed by 2014/15 and 2015/16 (Figure 4.3).
- The data set does not include long-term closures. The years 2014/15, 2015/16 and 2016/17 had more wet weather causing some larger incidents (for example large scale subsidence at Watford and Carlisle, flooding at Cowley Bridge and Cumbria, structural failures at Lamington Viaduct and Shakespeare Beach). These larger events caused lines to be closed for longer – in some cases months to years.³⁵⁴
- The prolonged heatwave in summer 2018 caused a 40 – 50% increase in asset failure rates on hot days compared with normal. For early hot days (April-June) this was up to 80%.³⁵⁵

Network Rail seeks to improve resilience as part of reinstatement projects, yet there is a need for sustained investment to deliver acceptable levels of resilience across the whole network. As set out in Chapter 1, impact indicators like rail incidents due to severe weather can be problematic for assessing progress in adaptation. A sensible proxy for assessing adaptation outcomes is to understand whether the underlying risks to climate change are changing, for example through trends in exposure and vulnerability. The TRaCCA programme recommended that there is a need for:

- Enhanced weather incident reporting and asset condition monitoring. Incident reporting requirements should include associated local weather conditions, and the consistency and accuracy of recorded weather conditions where delays occur or assets fail should be improved.
- Revised standards such as increasing the maximum temperatures used in rail asset design standards to fit with future climate projections, new rainfall threshold values for both design and operations and changing workforce safety standards to take into account working in adverse weather conditions.

³⁵³ ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*.

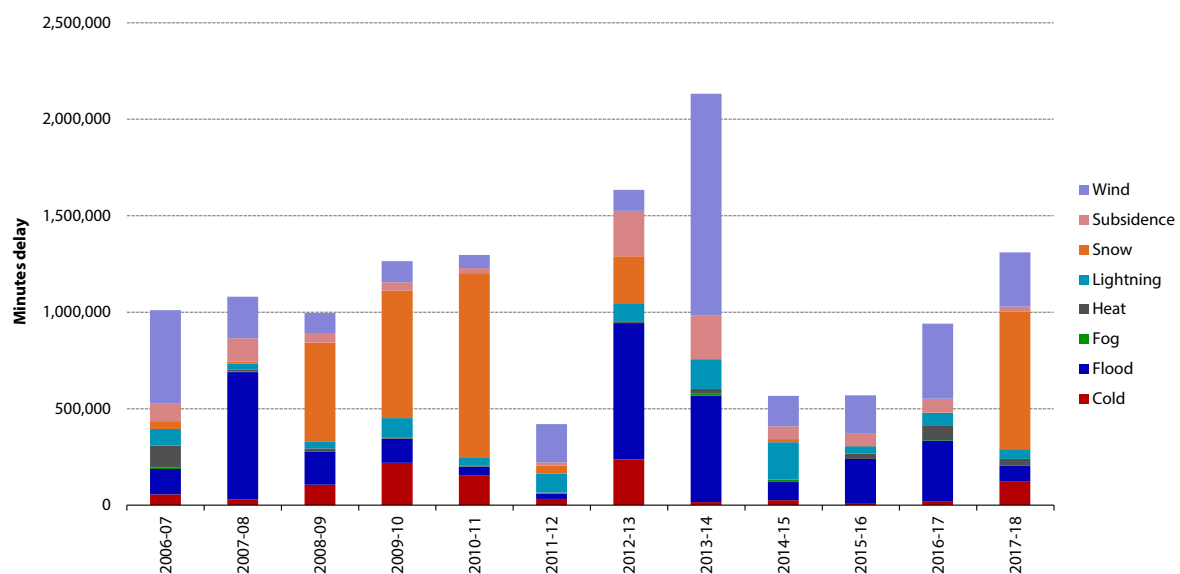
³⁵⁴ Discussion with Network Rail (2019). ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*.

³⁵⁵ Discussion with Network Rail (2019).

Network Rail are working to remediate bridge sites at high risk of bridge scour over the next five years as a priority.

Network Rail have deemed 181 bridge sites at an intolerable risk of bridge scour. Standards require the risk of these assets to be reduced within two years of the bridge being assessed. Remedial works are taking place with 43 scour risk reduction schemes completed in Control Period 5 Year 5 (against a target of 34). Plans are in place to remediate a further 55 assets during Control Period 6 Year 1.

Figure 4.3. The total number of minutes delay per type of weather related incident in England (2006-2007 to 2017-2018)



Source: ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*.

Notes: Figures recorded by Network Rail.

Conclusion

Route plans contain relevant actions and consider a 4°C global temperature scenario, whilst the climate strategy provides guidance to prepare for future action rather than specific measurable goals to reduce risk. These provide a good starting point for a framework to embed adaptation into decisions and investments.

Actions relating to rail infrastructure are associated with risk reduction, and it is likely they are reducing vulnerability in some areas, but we do not have the evidence at present to show this. The main indicators available for rail reliability is delay data and although of interest, as an impact indicator it does not give a sense of how vulnerability or exposure to climate risk is changing. It would be useful to have a better understanding of asset, slope and embankment condition and exposure, and the standards of new adaptation interventions.

4.7 Road network

What is the risk?

CCRA2 identified a number of areas where more action or research was needed to manage risks from climate change to the road network. The key impacts are associated with flooding, slope stability and bridge:

- Currently 6,600 km of the road network are located in areas susceptible to flooding, which could increase by 53 – 160% by the 2080s. For minor roads in particular, there has been no systematic assessment of the disruptions that have been caused by flooding, and the actions that have been taken as a result.
- It is not clear from the available evidence whether there has been a systematic evaluation of climate change risks to either the local road network or to local highway bridges. More research is needed to identify the number of bridges at risk of scour now and in the future and the level of adaptation underway nationally.

In contrast to the rail sector, the strategic road network is younger with much of it built since the 1950s, using modern materials and design standards. Temporary disruptions to the network from many weather events can generally be managed in the same way as other causes, such as roadworks and major accidents, as it is usually only the most severe weather that causes significant physical damage to the infrastructure.

CCC progress score for the strategic road network	Reason for progress score for the strategic road network
8	Plan score - high: Highways England (HE) is embedding resilience and climate change into plans and investments. HE is taking action to safeguard against flooding on the road network as set out in their climate change risk assessment, which covers all climate hazards. The assessment uses a high emission scenario (exceeding a 4°C global temperature rise by 2100) to identify vulnerabilities in its network, and update operational procedures and adaptation plans. HE has published both a Sustainable Development and Environment Strategy in 2017 which set out the high-level ambitions for the business. Risk score - medium: Actions in NAP2 are relevant, focussed particularly around flood risk, slope stability and bridges. HE is meeting performance targets, for example, HE met its 2018 target of at least 95% of the network in good condition. However, disruptive events remain a regular occurrence even in the current climate.

CCC progress score for the local road network	Reason for progress score for the local road network
5	Plan score - medium: Local highway authorities have a duty under the Highways Act 1980 to ensure highways, and the assets associated with them such as lighting and bridges, are well maintained. A Highways Code of Practice asks local authorities to take account of climate change when maintaining the local road network. This includes applying the latest UK Climate Projections, ensuring infrastructure is resilient to climate change and determining actions to address risks. However, there is no statutory requirement for them to use this guidance and there has been no systemic assessment of the disruptions that have been caused by flooding or extreme weather on local roads and the actions taken to reduce risk. Risk score - medium: Actions in the NAP relate to DfT sharing information with local highway authorities, however, it is the authorities' own responsibility to manage risks to the local road network. The Government allocates funding to local highway authorities to help improve local roads, including to increase resilience to weather, flooding and extreme heat.

Is there a good quality plan?

Are plans covered in NAP2?

NAP2 notes that Highways England is embedding resilience and climate change into plans and investments.

Highway's England's Climate Change Risk assessment uses a high emission scenario (equivalent to between 3.4°C and 5.3°C rise in global temperature by the end of the century) to identify vulnerabilities in its network, and feed into updates of operational procedures and adaptation plans.³⁵⁶

Environment Agency fluvial and pluvial flooding climate change projections are being embedded into the Design Manual for Roads and Bridges (DMRB) highways standards.³⁵⁷ These are used to assess and analyse the stability of earthworks such as cuttings and embankments, including any conditions that may contribute to future stability, such as drainage and groundwater conditions.

Local authorities are responsible for the local road network. A Code of Practice asks authorities to take account of climate change, although it is unclear how widely this is adhered to.³⁵⁸

³⁵⁶ Highways England (2016) *Climate Change Adaptation Risk Assessment Progress update 2016*.

³⁵⁷ EA flood allowances can cover both medium and high emissions scenarios.

³⁵⁸ UK Road Liaison Group (2016) *Well managed highways infrastructure – A Code of Practice*.

The local road network is particularly vulnerable to severe weather, as it accounts for 98% of the country's national highway network from major 'A' roads to minor country lanes across varied geographical areas.³⁵⁹ Local highway authorities have a duty under the Highways Act 1980 to ensure highways, and the assets associated with them such as lighting and bridges, are well maintained. In 2016 DfT published a revised 'Code of Practice: Well Managed Highway Infrastructure'. Climate change resilience features throughout the code and asks authorities to:

- Review and apply the latest UK Climate Projections (UKCP18) when assessing future risk and vulnerability.
- Ensure infrastructure is located, planned, designed and maintained to be resilient to climate change, including increasingly extreme weather events; and
- Understand the particular vulnerabilities facing local infrastructure from extreme weather and long term climate change to determine actions to address the risks.

Are there other plans not mentioned in NAP2?

Highways England has published both a Sustainable Development, and an Environment, Strategy in 2017³⁶⁰ which set out the high-level ambitions for the organisation.

These strategies are supported by an integrated Sustainable Development and Environment Action Plan, which includes actions which have assigned owners and timescales. A specific action within this plan is to ensure resilience to climate change is embedded in the activities of the business to reduce costs and increase safety. This action contains a requirement to review risks to the business, taking account of the evidence in UKCP18, and ensuring that standards are informed by the latest science on climate change.³⁶¹

The first Road Investment Strategy (RIS), for the period 2015 to 2020 includes commitments for the Environment Fund to improve resilience to flooding. The draft 'Road Investment Strategy 2' Government objectives say that Highways England should demonstrate that environmental considerations, including flooding, are mainstreamed across business activities. DfT and Highways England are examining the possibility of including a metric for drainage condition in the performance specification for the second Road Investment Strategy. These plans consider climate change more generally, rather than across a range of climate scenarios.

Do the plans address the risks in CCRA2?

Adaptation plans appear to take account of risks identified in CCRA2, while aiming to embed climate change adaptation into business as usual.

Some plans have been updated using the latest climate projections, and HE's risk assessment uses a high emissions scenario to identify vulnerabilities and set out actions. However, for local roads there has been no systemic assessment of the disruptions that have been caused by flooding and the actions taken to reduce risk.

³⁵⁹ DfT (2014) *Transport Resilience Review*.

³⁶⁰ <https://www.gov.uk/government/publications/highways-england-sustainable-development-strategy>

³⁶¹ Highways England (2017) *Environment Strategy*.

Is progress being made in managing risk?

Are relevant actions taking place?

Actions in NAP2 are relevant and focussed particularly around flood risk, slope stability and bridges:

- Highways England records high flood risk locations on their Drainage Data Management System. High risk locations are prioritised for improvement as part of scheduled road improvements or via designated fund projects (Box 4.3). HE has a performance metric to monitor the number of flooding hotspots and culverts mitigated. In 2017/18 HE mitigated 41 flooding hotspots, with 187 mitigated since 2015.³⁶² DfT and HE are currently considering the introduction of a drainage condition metric to their performance specification.
- DfT work with local authorities to identify effective measures to assess and address flooding risks, in particular for high risks sites. Information will be shared with highway authorities to ensure appropriate mitigation and contingency measures are put in place as part of their ongoing resilience plans.
- DfT is undertaking work to identify bridges which carry critical infrastructure that could potentially be a single point of failure for other infrastructure operators and could be at risk in a severe flood event or from bridge scour. A trial is taking place in Cumbria to test systems such as using specialist cameras on key bridges.³⁶³
- It is local highway authorities' responsibility to ensure they regularly undertake slope stabilisation monitoring as part of their highways maintenance service inspections. However, DfT in association with Lancashire County Council and a private sector company are trialling a new method of monitoring of a number of slopes within Lancashire County Council using LIDAR technology.

³⁶² Correspondence with Highways England (March 2019).

³⁶³ BridgeCat trial. Appendix A - NAP action update.

Box 4.3. Slowing the flow of water at Catterick, North Yorkshire

Improving resilience to flooding and reducing flood risk is a key objective of Highways England's Environment Designated Fund. In September 2012 a flood affected 130 properties and caused the A1, one of England's main north-south routes, to be closed for two days near Catterick in North Yorkshire. The cost of the flood to the regional economy was estimated to be more than £2 million.

Funding for a flood mitigation scheme was provided from the Environment Designated Fund, the Environment Agency Local Levy³⁶⁴ and North Yorkshire County Council. The scheme aimed to provide better flood protection and included:

- The creation of an innovative new flood storage reservoir opened in April 2018. The reservoir has helped slow the flow of Brough Beck, which floods in severe weather, by adding meanders to the Beck and creating a control structure incorporating 'hydro-brakes' to control the flow of water.
- In all, the flood scheme is able to hold 91 million gallons of water, reducing the risk of flooding to the highway and 149 properties.
- The creation of more than five hectares of new habitat including wetland and grassland habitats, adding additional natural capital benefits.

Source: Correspondence with Highways England (March 2019).

HE is taking further action to safeguard against all climate hazards in their climate change risk assessment progress report, including precipitation changes, increases in mean temperature and increases in wind speeds.³⁶⁵

The Government has allocated funding to help improve local roads, including through an Incentive Fund where authorities must show they are resilient to weather, flooding and extreme heat.

Government funding is available to local highway authorities for maintenance and resilience. For example:

- To access the Incentive Fund, local highway authorities in England outside of London must complete an annual self-assessment questionnaire, including questions on resilience. In order to be considered a top-level highway authority and retain government funding, authorities must show they have processes to manage extreme weather and other disruptions. The 'Resilient Highways Network' status is reviewed at least every two years. This includes demonstrating they are resilient to current weather, flooding and extreme heat.³⁶⁶
- In 2017/18 £100 million was provided to local authorities in England outside London for the Highways Maintenance Challenge Fund and £75 million through the Pothole Action Fund.³⁶⁷

³⁶⁴ As well as central government funding for flooding and coastal risk management, there are a number of other sources including a levy on local authorities raised by the EA.

³⁶⁵ Highways England (2016) *Climate Change Adaptation Risk Assessment Progress update 2016*.

³⁶⁶ See:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/755261/guidance-and-self-assessment-questionnaire.pdf

³⁶⁷ DfT (2019) *Road Conditions in England to March 2018*.

- In the Spending Review period (2015/16 to 2020/21) DfT will provide over £1.5 billion to local authorities through the Integrated Transport Block for capital investment in small transport improvement projects.³⁶⁸

Better indicators are needed to assess progress in managing the impact of climate risks on local roads. These could include monitoring how many authorities are considered top-level when applying for funding through the Incentive Fund.

Is there evidence that risk is being managed?

Highways England is meeting performance targets and road conditions are improving, although weather related delays on the network still occur.

Roads in better condition should be better able to withstand severe weather impacts. Failure to regularly maintain roads speeds up deterioration and higher temperatures, flooding and geotechnical movement can further compound this.³⁶⁹

DfT's Road Condition report found that the condition of classified local authority managed roads has remained stable in the most recent years (Figure 4.4).³⁷⁰ This follows a period of gradual improvement for classified 'A', 'B' and 'C' roads. Unclassified roads have not seen the same improvement over this period.

The condition of HE managed motorways has gradually improved since 2007/8, whereas HE managed 'A' roads have fluctuated. The Office for Road and Rail's (ORR) annual assessment of HE's performance indicates that HE met its target of at least 95% of the network in good condition.³⁷¹

HE delay data shows that there were 549 weather related incidents in 2018, compared to 441 in 2017. In both years flooding was the cause of most incidents (63% and 59% respectively).³⁷²

³⁶⁸ DfT (2019) *Road Conditions in England to March 2018*.

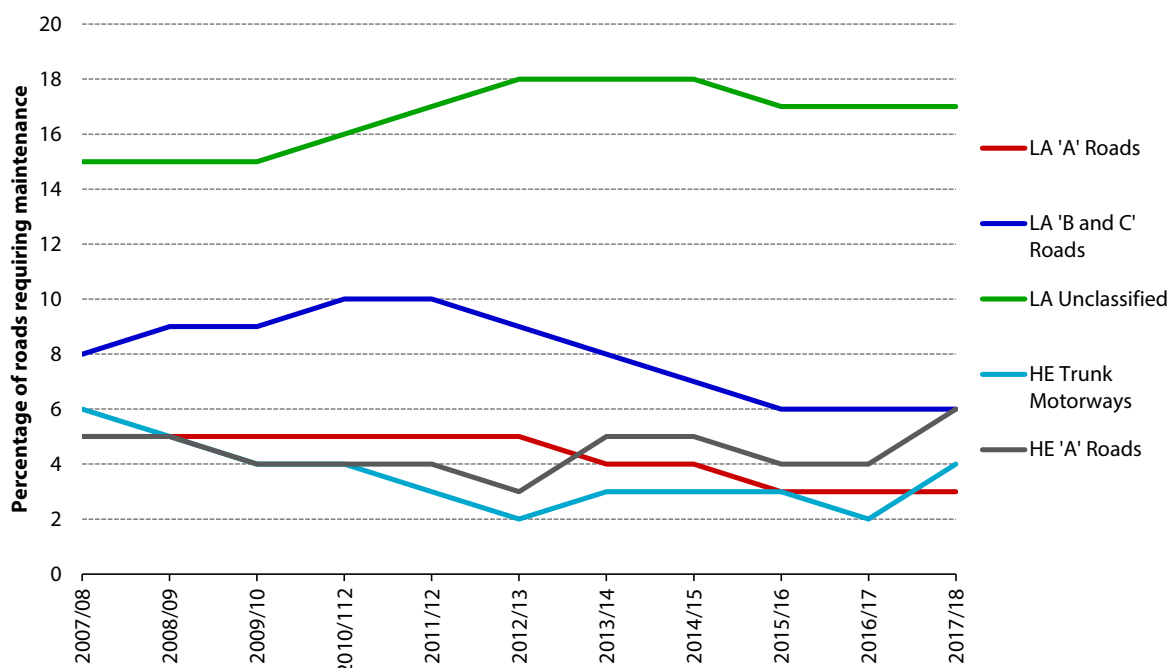
³⁶⁹ DfT (2014) *Transport Resilience Review*.

³⁷⁰ Condition is measured with the Road Condition Indicator (RCI) made up of several factors, which combine to give an overall measure of the state of the road. For example: rut depth (i.e. the depth of the ruts running along the length of the road caused by where the wheels of vehicles drive); 'bumpiness' along the road surface; texture of the road surface; cracking of the road surface.

³⁷¹ DfT (2019) *Road conditions in England to March 2018*.

³⁷² ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*.

Figure 4.4. Percentage of roads where maintenance should be considered in England by type (2007/08-2017/18).



Source: DfT (2019) *Road Conditions in England to March 2018*.

Notes: Figures for Local Authority managed roads are collected from Local Highway Authorities. Figures for Highways England managed roads are collected from Highways England for DfT.

Conclusion

Highways England is embedding resilience and climate change into plans and investments. The assessment uses a high emission scenario. A Highways Code of Practice asks local authorities to take account of climate change when maintaining the local road network, although it is unclear whether this is adhered to across all local authorities. More should be done to understand the disruption that has been caused by flooding on local roads and the actions taken to reduce risk. Actions in NAP2 are relevant, focussed particularly around flood risk, slope stability and bridges. Highways England is meeting performance targets and road conditions are improving.

4.8 Telecoms, Digital and ICT infrastructure

What is the risk?

ICT networks typically exhibit redundancy as a result of a diversity of systems and their network topology. However, failures have occurred due to extreme weather, which suggests that relying on redundancy alone has not been an effective adaptation strategy to date.

Data from Ofcom identifying outage incidents to networks and services between 2016 and 2017 showed that 1% (5 out of 648) of incidents were caused by severe weather (flood, storms or snow).³⁷³

In particular, the edges of networks where diversity is at its least are at risk of failure – typically near sparsely populated areas, or remote locations such as islands where loss of ICT for communication or control of other systems can cause the greatest problems.

CCRA2 stated that projected changes in climate may increase risk of damage in a number of ways:

- Increased flooding will damage key infrastructure assets such as cables, masts, pylons, data centres, telephone exchanges, base stations or switching centres.
- Fixed line calls and broadband data services rely on ‘root and branch’ networks comprising trunk cables and exchanges, telephone lines strung between telegraph poles, and street cabinets. An increase in frequency and intensity of storms will increase risk of damage.
- More intense or longer droughts and heatwaves can affect a range of ICT infrastructure because ground shrinkage can lead to failure of electrical, gas and water pipes, thereby damaging co-sited ICT infrastructure. High summer temperatures, as well as rapid fluctuations in temperature and humidity pose challenges to data centres in particular, which need to be kept cool to operate.

Insufficient information exists about the location of ICT and the criticality of its function in managing other infrastructure sectors. For some sectors, such as railways, ICT is important for the running of the network.

Other infrastructures may currently be less vulnerable to ICT disruption, but increased pervasiveness of ICT, particularly as a result of the increased uptake of ‘smart’ systems, is altering the interdependent risk profile of many infrastructure sectors and little is understood about the longer term implications of this for climate change risks.

³⁷³ Ofcom (2017) *Connected Nations Report 2017: Data analysis*.

CCC progress score	Reason for progress score
2	Plan score - low: There is no clear plan or process by the industry or Government with actions to manage long-term climate risks to the sector. There is an opportunity to show a plan to manage risks through the Adaptation Reporting Power (ARP). However, as ARP3 is a voluntary process there is no guarantee that organisations will report. Recent Ofcom and industry guidance asks providers to maintain services during flooding incidents, but do not include a consideration of climate change. Risk score - medium: Data are not available to assess how the risk is changing, though there has been activity since the first NAP period, especially in relation to flooding, which should reduce the vulnerability of some assets.

Is there a good quality plan?

Are plans covered in NAP2?

There is no clear plan or process within the industry or Government with actions to manage climate risks to the sector, including in 2°C and 4°C global temperature scenarios. NAP2 mentioned recent Ofcom and industry guidance which asks providers to ensure critical services are maintained during flooding incidents, but they do not account for long-term climate change.

The telecommunications sector considers flooding to be its most significant climate risk. There has been a push by the industry to improve resilience in the past couple of years following the National Flood Resilience Review (NFRR). Ofcom published revised security guidance in 2017, which contains explicit requirements for telecoms providers to ensure they meet the NFRR obligations and to ensure all sites (not just those in scope of NFRR) are protected from flooding. The NFRR does account for climate change within its weather and flooding scenarios (for example by using a 20% uplift on rainfall scenarios), however the review only looks at risks over the next 10 years. It is not known if there are any sanctions for not complying with Ofcom guidance.

The industry's own revised resilience guidelines (currently awaiting publication by the Government) have been strengthened to reference flooding and other severe weather.³⁷⁴ The guidelines ask providers to take account of the Environment Agency's Flood Outlines (which are for present day flood risk only, see Chapter 3).

For sites hosting or supporting critical services, where these locations are within the Environment Agency's Flood Outline, special considerations should be made to ensure the critical services can be maintained during a flooding incident. The guidelines specify that a service can be supported by delivery from an alternative site which should not be exposed to

³⁷⁴ EC-RRG (2018) *Resilience Guidelines for Providers of Critical National Telecommunications Infrastructure*.

the same set of risks as the primary site, and that the impacts of flooding to key inputs (e.g. electricity) should be considered.

Are there are other plans not mentioned in NAP2?

There appear to be no further plans outside those mentioned in NAP2.

There is an opportunity to show a plan to manage risks through ARP3. However, as ARP3 is a voluntary process there is no guarantee organisations will report.

Do the plans address the risks in CCRA2?

Plan go some way to address current weather resilience, but they do not consider longer-term climate change.

Is progress being made in managing risk?

Are relevant actions taking place?

There has been relevant action since the first NAP period, especially in relation to flooding.

The requirements of the NFRR have been met, with permanent flood defences installed in at-risk sites for a 1 in a 1000 year flood.³⁷⁵ Outages from flooding are infrequent, but can have serious and geographically far-reaching consequences when they occur as there is an increasing reliance on telecommunications and digital infrastructure by other infrastructure sectors.

The National Infrastructure Commission's infrastructure and digital systems resilience report found that the digital and ICT systems could well become more complex and interdependent as further systems and pressures are added to the network.³⁷⁶

The first NAP did not contain any actions for the sector. The second NAP includes a number of actions for industry, the Department for Culture, Media and Sport (DCMS) and Ofcom. These are mostly ongoing:³⁷⁷

- The sector has responded to the NFRR. All major providers surveyed at-risk sites and put significant investment into both temporary and permanent defences. All work on permanent flood defences was completed in 2018. This included putting regular reporting and monitoring in place alongside company visits by DCMS to view defences and to understand the extent of investment made by companies.
- DCMS has regular engagement with the Electronic Communications Resilience and Response Group (EC-RRG), an industry run group which leads on resilience and emergency response. DCMS engages via this group on a broad range of risks including flooding, other severe weather and climate change. Members have agreed to report voluntarily on climate change and the group has developed a standardised risk template.

In Ofcom's 2018 Connected Nations report, incident data were not published, but Ofcom did recommend that information on best practice in network design choices for flood resilience is made more widely available to companies. This is a positive step forward but there remains more to do.

³⁷⁵ Appendix A – NAP action update.

³⁷⁶ NIC (2017) *Infrastructure and Digital Systems Resilience Final Report*.

³⁷⁷ Appendix A - NAP action update.

Is there evidence that risk is being managed?

Data are not available to assess the vulnerability of the telecoms, digital and ICT sector to climate risks, though actions should reduce the vulnerability of some assets. A useful indicator would be to monitor the number of weather and climate related disruptions across the sector.

Conclusion

Plans are of a low quality as they do not include long-term impacts of climate change. However, appropriate actions are taking place which could begin to reduce vulnerability and exposure to climate change, though their effectiveness cannot be assessed.

4.8 Infrastructure interdependencies

What is the risk?

CCRA2 concluded that more action was needed to address cascading failures from interdependent infrastructure networks.

CCRA2 found that common standards of resilience would help with investment planning, and help emergency planners better understand the potential for service disruption arising from assets in their area. Enhanced arrangements for information sharing on critical risks due to interdependencies are required. This will help to create the right institutional conditions for adaptation in the next five years and in the long-term.

CCRA2 identified a number of cross cutting risks between infrastructure sectors, including the uptake of electric vehicles (EVs) and future rail electrification. EVs create a new demand on electricity infrastructure, placing further pressure on the system. The CCC's transport scenarios to achieve a net-zero emissions target assume growth in EV demand over the coming decades.³⁷⁸ If development of charging infrastructure is sensibly designed, EVs can provide greater opportunities for demand-side management of peak loads. A shift from liquid fuel to electric power displaces risks from disruptions to fuel distribution and supply, to disruption to electricity transmission and distribution networks.

³⁷⁸ CCC (2019) *Net Zero - Technical report*.

CCC progress score	Reason for progress score
1	Plan score - low: There is no systematic national assessment of interdependency risk or plan to improve resilience, including addressing risks and opportunities from climate change and a range of scenarios. Without a plan in place, important interdependent assets may be missed and issues remain around sharing of resilience data. Risk score - low: Research is going on and there has been a first pass at addressing vulnerabilities through the NIA. There are NAP actions to share data but these are facing challenges. DfT has assessed bridges that carry critical infrastructure and other organisations have considered interdependencies as shown in ARP reports. However, strategic actions to reduce risk do not appear to be happening. The Environment Agency's updated Long-term Investment Scenarios (LTIS) found that over 40% of infrastructure is at current risk of flooding, either directly or due to dependence on other sectors. While assets are being protected to a standard set out in the National Flood Resilience Review, it is not known whether risks are being fully managed.

Is there a plan?

Are plans covered in NAP2?

There is no systematic national assessment of interdependency risk or plan to improve resilience in NAP2, including addressing risks and opportunities from climate change.

Infrastructure networks do not operate in isolation. Services, in particular, are reliant on power, fuel supplies, and ICT. Transport links including local roads are important for logistics and to allow staff to travel to work. Failures caused by interdependencies are not systematically recorded, and despite a scaling up of research effort in recent years,³⁷⁹ the scale of the issue remains largely unknown.

There remains no overarching plan or framework for the consideration of climate change in relation to how these risks are be managed. The onus rests with individual organisations to identify and manage interdependent risks in the same way as they would any other business risk.

³⁷⁹ For example through Infrastructure Transition Research Consortium and Data Analytics Facility for National Infrastructure (ITRC).

Are there are other plans not mentioned in NAP2?

The Civil Contingencies Act places a duty on Category 1 and 2 responders to share information to enhance co-ordination, and the Green Book Guidance provides tools to identify and manage interdependencies that affect resilience in projects.³⁸⁰

Do the plans address the risks in CCCRA2?

Although there are no overarching plans to address risks, NAP2 sets out actions that aim to address gaps highlighted in the CCRA, such as implementing common standards of resilience in line with the NFRR and overcoming data sharing barriers. However, without a comprehensive plan or strategy by Government, it is likely that important climate change risks from infrastructure interdependencies will continue to be overlooked.

Is progress being made in managing risk?

Are relevant actions taking place?

NAP actions are relevant (if limited) and are mostly focused around sectors and infrastructure groups working to overcome barriers to assessing interdependencies.

Many infrastructure owners have invested to improve infrastructure resilience, as outlined in the National Flood Resilience Review (NFRR). The NAP includes actions, which are ongoing, to help ensure arrangements are in place to share data effectively on locally significant infrastructure sites with Local Resilience forums:

- The Cabinet Office's National Infrastructure Resilience Council (NIRC) aims to bring together utility companies to share information about the location of their assets and to take a coordinated approach to flood resilience.
- Work is ongoing to share data with Local Resilience Forums on locally significant infrastructure sites, with a number of sectors using the Resilience Direct online platform.³⁸¹ The platform is an online private 'network' which enables civil protection practitioners to work together – across geographical and organisational boundaries – during the preparation, response and recovery phases of an event or emergency. The platform is a secure site, and therefore requests to use evidence provided by other users have to be agreed by the user groups.

NAP2 also includes actions which have either been revised or delayed:

- The Cabinet Office were due to carry out a biennial survey of all local responders and Local Resilience Forums in England and Wales. This would have included specific questions on data sharing on locally significant infrastructure and the number of local responders that have a specific procedure in place to share data. The Cabinet Office should clarify whether the same level of data is being collected from the Resilience Direct platform.
- The Infrastructure, Resilience and Security Working Group (IRSWG) sub group of the National Security Council was tasked to produce a tested methodology by which HMG can identify cross-sector interdependencies. The group reviewed a number of models to ascertain whether these could be utilised to identify interdependencies, however found a number of security challenges due to the sensitivity of Critical National Infrastructure data.

³⁸⁰ HM Treasury (2015) *Valuing infrastructure spend: Supplementary guidance to the Green Book*.

³⁸¹ Defra (2018) *National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting*.

The CCC reported in 2017 that the UK Regulators Network was committed through their infrastructure and resilience network to continue to share best practice to promote and monitor good asset management. It is not clear what progress has been made.

Organisations are working together to better understand interdependencies, however there is little evidence that strategic actions to reduce exposure or vulnerability to climate change are happening.

As set out in this report there is evidence that some organisations are working with other sectors to understand interdependencies (for example water, power, and transport). ARP organisations have previously recognised some risks from interdependencies in their reports however, it is still not clear if actions are being taken to reduce exposure or vulnerabilities. Reporting organisations should ensure that ARP3 reports include actions to mitigate interdependent risk.

A new computational platform launching in 2019 will provide a secure yet accessible National Infrastructure Database which can be used for planning adaptation actions.

The UKCRIC Data & Analytics Facility for National Infrastructure (DAFNI) has been developed by the Science and Technology Facilities Council and multiple UK universities. It will provide a secure yet accessible National Infrastructure Database; a new software platform to enable analysis, modelling and simulation of national infrastructure systems and their interdependencies; and, visualisation facilities to enable access to and interpretation of the results by researchers and practitioners.³⁸²

The National Infrastructure Commission has been tasked by the Chancellor to examine the resilience of the UK's infrastructure, including cross-sectoral interdependencies.

In the first phase, running until spring 2020, the National Infrastructure Commission is considering what action Government should take to ensure that infrastructure can cope with future changes, disruptions, shocks and accidents, including those associated with climate change. The Commission will make recommendations to the Government on how best to assess infrastructure resilience, sharing of good practice, the actions needed and data collection or analysis required to inform the next National Infrastructure Assessment.

The key outcome is expected to be a framework for infrastructure resilience, including cross-sectoral interdependencies, which will be used in the next National Infrastructure Assessment, due in 2023.

Is there evidence that risk is being managed?

Over recent years there have been improvements in the understanding of infrastructure interdependencies although issues with assessing the level of risk remain.

The NAP action updates from infrastructure sectors indicate that work is either ongoing or complete to protect assets to a 1-in-1000 year flood event (river and coastal) through the NFRR. Where key infrastructure is protected it can provide multi-benefits, but, without a plan or strategy by Government, there remains a possibility of assets that are important because of their interdependencies with other infrastructure systems being missed and therefore under protected.

A useful indicator would be to record and monitor impacts caused by cascading failures from weather and climate related disruptions.

³⁸² See: <https://www.itrc.org.uk/dafni-data-and-analytics-facility-for-national-infrastructure/>

The Environment Agency's Long-term Investment Scenarios show that over 40% of transport and utilities infrastructure are at current risk of flooding, either directly or due to dependence on other sectors.

The Environment Agency worked with the University of Oxford to explore the impacts of river and coastal flooding on transport and utilities infrastructure for its latest Long Term Investment Scenarios.³⁸³ The analysis included the sites and networks themselves and the interdependencies between networks and found that 41% of transport and utilities infrastructure assets are in areas at risk of flooding, comprising 36% at direct risk of flooding, and 5% at risk due to dependencies on electricity infrastructure flooding.

The work used a unique set of infrastructure modelling tools, although it was limited to describing the extent to which properties in England are served by infrastructure located in (or dependent on others in) areas at risk of flooding as the EA did not have access to data about the resilience of individual sites. The main limitations were on the availability of data, for example: infrastructure location; site resilience; network redundancy; disruption duration. The telecommunications sector was not included as no data were available.

Conclusion

Plans do not clearly address the risks identified in CCRA2. NAP2 actions aim to address data sharing and implementing common standards of resilience in line with NFRR, although issues remain with accessing data and assessing the level of risk.

³⁸³ Environment Agency (2019) *Long-term investment scenarios*.

Chapter 5: Business



5.1 Introduction

Climate change risks are increasing for business and industry in England. Through international supply chains, distribution networks and global markets, businesses are exposed to risks from extreme weather, including flooding and water shortages around the world. Climate change could also present opportunities to businesses through increase in demand for some existing goods and services, including those specifically related to adaptation (e.g. flood defence engineering), and the emergence of opportunities for new products and services.

Since our last report in 2017, there has been an increasing focus on climate change within the business community. Much of this focus is driven by initiatives to make sure that risks are being addressed in order to ensure the stability of the financial system, and to assure investors about the long-term viability of their investments and that risks are being addressed. The most significant of these initiatives is the Task Force on Climate-Related Financial Disclosures (TCFD). The TCFD recommends that organisations report how they will be impacted and the actions they are taking in response to all relevant climate change risks and opportunities, as well as how this is incorporated into their governance, strategy, risk management, metrics and targets. However, the only climate scenario the TCFD stipulates must be included is a 2°C or lower scenario for consistency with the goals of the Paris Agreement. While planning for 2°C may make sense for use in climate change mitigation (transition risk) planning, adaptation (physical risk) planning should also consider physical risks in higher climate scenarios. TCFD, and similar initiatives, are relevant to all of the adaptation priorities within this chapter, though they are discussed primarily in the first 'Impact on business of extreme weather events'.

It is important to note that the TCFD and other initiatives are primarily focussed on large, publicly listed organisations, with a focus on the financial sector. Small and Medium Enterprises (SMEs), as defined by the number of employees, account for 5.7 million or 99.9% of all UK private sector businesses, 60% of employment and 52% of turnover.³⁸⁴ These businesses are a significant part of the UK economy and have fewer resources to adapt to the risks and opportunities arising from climate change than those targeted by TCFD and other initiatives. It is, therefore, critical to distinguish between different types of business in assessing preparedness and considering where further support may be required.

Whilst it is ultimately for each business to determine their strategy for adapting to climate change, the Government has a role in enabling and promoting private sector adaptation. Future uncertainty means that, for many organisations, deciding on the best approach to take is too complex, without a single, trusted and reliable source of information and support. Decisions made today which are based on inadequate information risk 'lock-in' to negative impacts in the future and missing out on the opportunity to achieve long-term benefits by adapting now. Investors, Environmental and Social Governance (ESG) agencies and civil society are making the most of existing information in the public domain. There are now multiple assessments (FTSE4Good Index, CDP's scores) of companies' response to climate change, therefore providing an additional incentive for companies to adapt, subject to having adequate information to do so.

NAP2 sets out an overall vision that 'UK businesses are resilient to extreme weather and prepared for future risks and opportunities from climate change.'³⁸⁵

³⁸⁴ BEIS (2018) *Annual Business Population Estimates*.

³⁸⁵ Defra (2018) *The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting*.

Most of the actions related to business within NAP2 are to be achieved through the publication of annual reports, new assessments or Government responses. Others will be achieved through the continuation of existing activities such as the Adaptation Reporting Power (ARP) reporting or considering the need for new voluntary standards. It is difficult to assess progress towards the overall vision in NAP2 given its breadth and lack of timescales, and therefore to determine whether the actions in NAP2 are effective in enabling and promoting adequate adaptation.

5.2 Impact on business of extreme weather events

What is the risk?

CCRA2 highlighted the growing impact that climate risks and extreme weather are having on business and industry. Flooding and extreme weather events that damage assets and disrupt business operations pose the greatest risk to English businesses now and in the future:

- Companies operating in flood risk areas are exposed to direct damages to buildings and assets, and indirect impacts on sales, production and reputation. Businesses not directly at risk but located in affected towns may suffer knock-on impacts from disrupted infrastructure and custom being postponed or lost to competitors elsewhere.
- Businesses located or operating in coastal locations face additional risks from sea level rise. Flooding and coastal erosion can lead to loss of coastal business locations, or access to them, and disrupt infrastructure provision as well as have indirect impacts on businesses.
- Extreme weather events can impact labour productivity through denying workers access to sites, preventing them from working remotely, or causing them to have to take leave to deal with problems at home.
- Workers engaged in particular sectors or occupations, for example heavy outdoor manual labour, are likely to be at the greatest risk of heat stress, though overheating indoors will also impact employee productivity. The limited evidence available suggests sustained periods of higher temperatures, for example the 2003 heatwave, resulted in large losses for the UK manufacturing sector.

CCC progress score	Reason for progress score
2	Plan score - low: Complying with the requirements of the Task Force on Climate-related Financial Disclosures (TCFD) creates an incentive for businesses to plan for how they may be impacted by climate change, though there is little evidence that planning is taking place for more than a 2°C increase in global temperature. TCFD is also less likely to influence SMEs, the majority of businesses in England. Risk score - medium: Increasingly, large investors and shareholder groups are putting pressure on the companies they invest in to change their reporting practices and give greater consideration to climate change. While many large businesses have expressed support for the TCFD, this has not yet led to better assessment and planning for climate change risks and the current guidance may not lead to consideration of higher climate change scenarios relevant for adaptation. Many businesses still do not have basic continuity plans for extreme weather.

Is there a good quality plan?

Are plans covered in NAP2?

NAP2 acknowledges the risks businesses face from extreme weather but does not set out specific plans to address these risks.

NAP2 highlights the very broad 25 Year Environment Plan (25-year Plan) goal 'to ensure that all policies, programmes and investment decisions take into account the possible extent of climate change this century'. However, there is no plan set out in the NAP or 25-year Plan that explains what this means in practice, considers the long-term risks from climate change or sets out appropriate actions for achieving the goal. There is a range of more ad hoc plans mentioned throughout NAP2:

- The Flood and Coastal Erosion Risk Management section of NAP2 refers to the 25-year Plan goal: 'to reduce the risk of harm to people, the environment and the economy from natural hazards including flooding and coastal erosion by taking appropriate action.' It states that it will support adaptation that reduces the damage to homes, infrastructure and local services so that costs to industry (including insurers) are reduced and recovery is quicker. A specific way of helping achieve this is the development of an industry-owned voluntary code of practice. Other ways that are mentioned, such as information provision, ensuring collaboration among the public, private and third sectors and boosting long-term resilience of business, are general with no further detail about what they will involve or how and when they will be achieved.
- NAP2 notes that the Non-Financial Reporting Directive was transposed into UK regulations in December 2016. The first reports, for financial years starting on 1 January 2017, are being filed and Defra states this will form an important part of its evidence base.

The regulations require financial reports to contain sufficient information to understand the company's development, performance and position and the impact of its activity relating to environmental matters (including the impact of the company's business on the environment). The regulations are no more prescriptive than this, so the degree to which they will result in companies reporting on climate change risks remains to be seen.

- Defra acknowledges the risk of higher temperatures in working environments identified in CCRA2 and states it is working to ensure the appropriate departments, including the Department for Business, Energy and Industrial Strategy (BEIS), the Ministry of Housing, Communities and Local Government (MHCLG) and Department of Health and Social Care (DHSC), take this commitment forward, but NAP2 does not set out any specific actions to achieve this.

NAP2 plans for agricultural productivity, commercial forestry and commercial fisheries and aquaculture are covered in Chapter 2. As for businesses overall, nearly all of these are SMEs and will be affected in similar ways by the existence and quality of plans discussed in this section.

Defra is working with the British Standards Institute on standards designed to help organisations make better plans for adaptation.

The British Standards Institution (BSI), the UK's National Standards Body, has led the development of a new international standard set to publish in June 2019, *'ISO 14090 Adaptation to climate change -- Principles, requirements and guidelines'*.³⁸⁶ Organisations will be able to use this standard to understand what is meant by adaptation to climate change and how they can create new or adjust existing adaptation plans based on the risks and opportunities they face. A standard on Natural Capital Accounting is also being developed which will help organisations to identify risks and incorporate the benefits and costs of investments within their balance sheets, improving their long-term investment decisions. As noted in NAP2, Defra is working with BSI to identify other needs for standardisation in this area, such as adaptation reporting, as well as following standards in development on climate change risk assessment, decision making processes using adaptation pathways, sustainable finance including green bonds and guidance on climate adaptation for local government.³⁸⁷

Are there other plans not mentioned in NAP2?

National plans and policies to help businesses prepare for extreme weather are limited.

There are no specific national plans or targets for making businesses more resilient to climate risks such as flooding, extreme cold, drought and higher temperatures. The Industrial Strategy provides a long-term plan for some aspects of business but does not consider the risks from climate change.³⁸⁸ Businesses would benefit from wider planning for flood risk or water resources management and the consequences. Protecting businesses is a stated aim of Defra's six-year investment plan for flood and coastal defence, though no national target exists as yet (see Chapter 3).

There have been developments in the ways listed/large businesses are encouraged to consider and report on the impacts of climate change now and in the future, with the biggest of these developments being the recommendations of the Task Force on Climate-related Financial Disclosures.

³⁸⁶ <https://standardsdevelopment.bsigroup.com/projects/2016-03370>

³⁸⁷ Appendix A – NAP action update.

³⁸⁸ HM Government (2017) *Industrial Strategy: building a Britain fit for the future*.

In the last two years there has been a significant increase in the pressure on companies to disclose information on how the risks and opportunities from climate change could affect them, and the actions they are taking in response. This pressure has been accompanied by initiatives to ensure the consistency and usefulness of the information disclosed. Chief among these are the recommendations of the Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD) which the UK Government has endorsed, but not made mandatory.³⁸⁹ To comply with the TCFD, businesses must disclose specific information in relation to how their governance, strategy, risk management, metrics and targets help them assess and manage their response to both transition (or mitigation) risks and opportunities, and physical (or adaptation) risks and opportunities. Compliance with the TCFD is not mandatory and perhaps as a result, reviews have found that businesses are not yet implementing the recommendations effectively.³⁹⁰

Organisations like the Climate Disclosure Standards Board (CDSB),³⁹¹ Sustainability Accounting Standards Board (SASB)³⁹² and CDP³⁹³ have created further guidance to encourage greater disclosure and have aligned their requirements with the TCFD to prevent unnecessary reporting and minimise additional burdens on business. Investors are increasingly proactive in demanding this information and using their voting rights at Annual General Meetings (AGMs) to put pressure on organisations to consider their long-term risks from climate change. Credit ratings agencies are similarly emphasising ESG concerns, including climate change, in how they assess companies' creditworthiness in response to increased interest from lenders and institutional investors.

Complying with the TCFD recommendations will lead to more useful information being reported and create incentives for businesses to assess how they may be impacted. However, the current guidance does not encourage consideration of higher climate change scenarios and the voluntary approach is unlikely to be strong enough.

The only climate scenario the TCFD stipulates must be included is a 2°C or lower scenario for consistency with the goals of the Paris Agreement. It does also suggest that organisations should look at multiple climate scenarios, including those consistent with increased physical risks where relevant, but it is ultimately up to organisations if they look at scenarios involving greater than a 2°C global temperature rise by 2100, such as 4°C. While planning for 2°C may make sense for use in climate change mitigation planning, it is a very conservative scenario to use for adaptation planning. Even if all countries deliver their current intended nationally determined contributions (INDCs) to reduce emissions of greenhouse gases as pledged to the UN, the world is still on course for a 3°C or higher scenario.³⁹⁴

At present the TCFD is a voluntary initiative, with debate about whether it needs to be made mandatory in future to ensure widespread and consistent reporting. The prevailing view during the Environmental Audit Committee's (EAC) green finance inquiry was that reporting practices should be allowed to develop for a period of two to five years, after which businesses would be required to report on a 'comply or explain' basis.³⁹⁵

³⁸⁹ <https://www.gov.uk/government/news/uk-government-launches-plan-to-accelerate-growth-of-green-finance>

³⁹⁰ Task Force on Climate-related Financial Disclosures (2018) *2018 Status Report*.

³⁹¹ <https://www.cdsb.net/what-we-do/task-force-climate-related-financial-disclosures>

³⁹² <https://www.sasb.org/standards-overview/sasb-and-others/>

³⁹³ CDP (2019) *Disclosing in line with the TCFD's Recommendations in 2019*.

³⁹⁴ CCC (2019) *Net Zero: The UK's contribution to stopping global warming*.

³⁹⁵ Environmental Audit Committee (2019) *Greening Finance: embedding sustainability in financial decision-making*.

The EAC recommended that the Government should set a deadline of 2022 by which it expects all listed companies and large asset owners to report on climate-related risks and opportunities in line with the TCFD recommendations on a comply or explain basis. The Government will respond to this recommendation through its forthcoming Green Finance Strategy (which at the time of writing had not yet been published).

In addition to TCFD there have also been other changes which will encourage greater consideration of the implications of climate change.

The Government commissioned an independent Advisory Group to give advice on how to grow a culture of social impact investing in the UK. The Advisory Group's report noted the rise of Environmental Social and Governance (ESG) factors, including climate change.³⁹⁶ It also noted pioneering pension funds such as the Legal & General Investment Management (LGIM) Future World Fund that tracks climate change parameters, and increasing bond issuance through initiatives like the Climate Bond initiative. In response to the Advisory Group's report, the government committed to work with the investment and savings industry to support the launch of further social impact investment funds and established a Taskforce to progress the report's recommendations.³⁹⁷

A range of consultations and reviews have been carried out or are planned by Government departments, regulators or taskforces that will place further requirements on organisations to consider the impacts of climate change (Box 5.1). There is currently more mandatory reporting for climate change mitigation than adaptation and there may be opportunities to further integrate the two in future. New regulations for Streamlined Energy and Carbon Reporting brought in additional disclosure requirements for quoted companies and introduced requirements for large unquoted companies and limited liability partnerships to disclose their annual energy use and greenhouse gas emissions.³⁹⁸

³⁹⁶ Advisory Group appointed by HM Government (2017) *Growing a Culture of Social Impact Investing in the UK*.

³⁹⁷ HM Government (2018) *Government Response to Advisory Group Report on 'Growing a Culture of Social Impact Investing in the UK'*.

³⁹⁸ HM Government (2019) *Environmental Reporting Guidelines: Including streamlined energy and carbon reporting guidance*.

Box 5.1. Consultations and reviews to strengthen organisations' consideration of climate change

- The Department for Work and Pensions announced that from 1 October 2019, pension fund trustees will be required to set out, in their statement of investment principles (SIP), how they take account of financially material considerations and stewardship. 'Financially material' includes, but is not limited to, environmental, social and governance (ESG) factors, including climate change.
- The Financial Conduct Authority consulted on climate change and green finance in October 2018. This included rule changes that would require the Independent Governance Committees of contract-based pensions to report on how they manage environmental risks and how they take account of members' ethical concerns. It has also said that it will now highlight to issuers the need to make adequate disclosures regarding how environmental risks affect the valuation of a listed company's securities and how these matters are managed by the company.
- The Financial Reporting Council (FRC, which is to be replaced by the Auditing, Reporting and Governance Authority following a recommendation from the Kingman Review³⁹⁹) has taken a range of actions to encourage transparency of climate-related risks. Updated versions of the UK Corporate Governance Code and Guidance on the Strategic Report ask companies and their boards to consider opportunities and risks to the future success of the business and how broader matters, including climate change, may impact long-term performance. The FRC is also considering specific disclosures by companies that ClientEarth has brought to its attention.
- The BEIS Select Committee recommended that the Brydon Review should consider extending the scope of audit to cover the entire annual report. Consideration of climate change or sustainability can, at present, be reported in parts of the annual report that are not currently audited.
- The Prudential Regulation Authority consulted on enhancing banks' and insurers' approaches to managing the financial risks from climate change. It has now published a Supervisory Statement setting out its expectations for a strategic response, covering; governance; embedding climate change in existing risk management; scenario analysis; and disclosure. A new Climate Financial Risk Forum will explore what tools and guidance are needed for organisations to provide this.
- The European Commission is consulting on revised guidelines that propose climate-related disclosures for each of the five reporting areas in the EU Non-Financial Reporting Directive (NFRD). The guidelines are intended for use by companies for which climate is a material issue. The Commission expects that this will apply to most companies under the scope of the NFRD and that those which conclude it does not apply to them should explain why.

Sources: Department for Work and Pensions (2018) *Clarifying and strengthening trustees' investment duties - Government response*; Financial Conduct Authority (2018) *Climate change and green finance*; <https://www.frc.org.uk/frc-for-you/blogs-and-podcasts/blog-changing-climate-changing-reporting>; Business, Energy and Industrial Strategy Committee (2019) *The Future of Audit*; Prudential Regulation Authority (2019) *Enhancing banks' and insurers' approaches to managing the financial risks from climate change*; European Commission (2019) *Consultation document on the update of the non-binding guidelines on non-financial reporting*.

Many businesses do not have continuity plans in place for extreme weather and some may rely on insurance alone.

Despite evidence suggesting that the benefits of having a business continuity plan outweigh the costs of producing one,⁴⁰⁰ many businesses, particularly smaller ones, do not have one. Organisations often develop plans only after they have been impacted by an extreme weather

³⁹⁹ <https://www.gov.uk/government/news/audit-regime-in-the-uk-to-be-transformed-with-new-regulator>

⁴⁰⁰ Chartered Management Institute (2013) *Weathering the storm. The 2013 business continuity management survey*.

event. The latest available data (now four years old) suggest that only 25% of businesses with fewer than 10 employees have a resilience plan in place that specifically includes severe weather.⁴⁰¹

Businesses may rely on insurance in the event of extreme weather. The Flood Re reinsurance scheme only covers residential properties so businesses need to look to other targeted schemes for insurance to cover flood risk. The British Insurance Brokers Scheme developed new products and services to provide businesses with commercial flood insurance. It is not known to what extent businesses have taken up these products. The Federation of Small Businesses has developed their own insurance scheme for members.⁴⁰²

Do the plans address the risks in CCRA2?

CCRA2 found that more action was needed to ensure that businesses have the right incentives, information and tools to adapt to increasing flood risk, and that more research was required to understand the risks from loss of coastal locations and reductions in employee productivity due to infrastructure disruption and higher temperatures. NAP2 acknowledges these risks but does not commit to providing further tools or carrying out research beyond existing commitments through the ARP or work with other Government Departments. Complying with the requirements of the Task Force on Climate-related Financial Disclosures (TCFD) creates an incentive for businesses to plan for how they may be impacted by climate change, though this is unlikely to address the CCRA2 risks in full and is also only likely to apply to larger businesses.

Is progress being made in managing risk?

Are relevant actions taking place?

NAP2 actions for the impact on business of extreme weather could lead to improved reporting and increased resilience but do not have enough detail on what they aim to achieve.

- Information will be collected through the third cycle of adaptation reporting between 2019 and 2021, from infrastructure operators and their regulators, on the scale of interruptions impacting on productivity.
- The Government will consider the recommendations of the Green Finance Taskforce and respond in due course. The Green Finance Taskforce recommended the Government take steps to implement the recommendations of the TCFD, including integrating them into existing corporate governance and reporting frameworks and conducting a review of disclosure in 2020.
- Under flood and coastal erosion risk management in the People and the Built Environment Chapter of NAP2 there are actions to ensure that national planning policies are effective in managing the risks and impacts of coastal erosion and to support an industry-owned voluntary code of practice, which are described as enabling both households and businesses to increase their resilience to flooding.

While many large UK organisations have expressed support for the TCFD, it is not yet clear that this is necessarily leading to alignment with the recommendations and better assessment and planning for climate risks.

⁴⁰¹ Federation of Small Businesses (2015) *Severe Weather: A More Resilient Small Business Community*.

⁴⁰² Federation of Small Businesses (2018) *Small businesses and flooding: What are the options?*

As of June 2019, nearly 800 organisations are supporting the TCFD, with approximately 110 of these located in the UK. These are large organisations with many being asset management firms or pension funds. This reflects the focus of TCFD and possibly that SMEs and organisations in other sectors lack the capacity to even begin to comply with TCFD recommendations. A survey by EcoAct found that 41% of FTSE100 companies mention or align to the recommendations of the TCFD.⁴⁰³ However, a smaller percentage, 28%, of FTSE100 companies assessed climate risks and had clear plans to mitigate them and only 18% mention, use or plan to use climate scenario analysis to inform their sustainability strategies.

The TCFD published a second status review in June 2019.⁴⁰⁴ This review concluded that while the majority of the companies reviewed reported some climate-related information, further work is needed for disclosures to contain more decision-useful, climate-related information. In particular, companies do not often disclose the actual or potential climate-related financial impacts that they have or would incur from climate change and extreme weather. The aspect of the recommendations where companies performed worst was the use of different climate-related scenarios to test their strategy.

These limitations are mirrored in analysis by the Carbon Disclosure Project (CDP) and the Climate Disclosure Standards Board.⁴⁰⁵ Based on a core sample of 80 companies' management reports, only 23% had a clear statement in their management report that climate or environment was integrated into their due diligence processes. Only 15% of the companies assessed provided information on board oversight on climate-related matters.

A few large investors are beginning to put pressure on the companies they invest in to change their reporting practices and give greater consideration to climate change. Credit Ratings Agencies are also starting to incorporate climate risk into their assessments of creditworthiness.

Increasingly, large investors, such as Blackrock and Legal and General Investment Management (LGIM), are writing to companies they invest in and using their voting rights at AGMs to pressure organisations to fulfil their responsibilities to shareholders and consider their long-term risks from climate change.⁴⁰⁶ According to data from Proxy Insight, the number of investor resolutions on climate change doubled to 42 between 2013-14 and 2016-17. In response to pressure from shareholder groups and dialogue with large investors, BP, Exxon Mobil and Shell have set hard targets, tied these to executive pay and also committed to improving their reporting. However, at present these examples primarily relate to mitigation rather than adaptation.

Credit ratings agencies assess the capacity and willingness of issuers of debt, such as corporations or governments, to meet their financial obligations. As such, they have the ability to influence company behaviour as investors will use their ratings in making investment and business decisions.

In response to increased interest from lenders and institutional investors, S&P Global has launched a programme to evaluate ESG concerns, including a company's long-term preparedness for plausible future disruptions, such as climate change.⁴⁰⁷ How well climate

⁴⁰³ EcoAct (2018) *The Sustainability Reporting Performance of the FTSE 100*.

⁴⁰⁴ Task Force on Climate-related Financial Disclosures (2019) *2019 Status Report*.

⁴⁰⁵ CDP and CDSB (2018) *First Steps - Corporate climate and environmental disclosure under the EU Non-Financial Reporting Directive*.

⁴⁰⁶ *Money managers: the new warriors of climate change*. <https://www.ft.com/content/c245af4a-f875-11e8-af46-2022a0b02a6c>

⁴⁰⁷ S&P Global (2018) *S&P Global Ratings' Proposal For Environmental, Social, And Governance (ESG) Evaluations*.

change can be incorporated will depend on the quality of reporting through initiatives like the TCFD, which is key particularly for helping credit ratings agencies look further ahead than they have previously done.⁴⁰⁸

The Bank of England identified that the majority of banks are beginning to treat the risks from climate change like other financial risks but many still have some way to go to identify and measure the risks from climate change comprehensively.

In its 2018 report on climate change, the Bank of England reviewed the risks and opportunities to the UK banking sector.⁴⁰⁹ Based on practice to date, the financial risks of climate change exceed the planning horizons of the UK banking sector, which are of about four years. The Bank of England's report notes that climate change has now moved beyond just a Corporate Social Responsibility (CSR) issue and the strategy, targets and appetite for risk are beginning to be discussed at board level. The report noted that the uncertain and extended time horizons of physical risk factors, together with a lack of detailed regional data, made it difficult to assess potential losses. Credit risks from uninsured losses could be relevant to a wide range of UK banks. Representatives from the insurance sector warned that a 4°C+ world would not be insurable. The Financial Conduct Authority and Prudential Regulation Authority staged the first meeting of the Climate Financial Risk Forum to help firms in the financial sector implement the forward-looking, strategic approach necessary to minimise risks.

Central banks and supervisors have established a Network for Greening the Financial System (NGFS) to share best practice. In its first comprehensive report,⁴¹⁰ the NGFS made six recommendations on what central banks and supervisors can do to manage climate-related risks and how policymakers can support this work. The recommendations covered: integrating climate-related risks and sustainability factors into decision making; addressing data gaps and capacity issues; and achieving robust and consistent disclosures. The NGFS is an open-ended initiative and has set out a number of technical deliverables, including voluntary guidelines on scenario-based risk analysis, which it will deliver over the coming months.

Is there evidence that risk is being managed?

Estimates of economic impact demonstrate that many businesses are vulnerable to extreme weather. However, these estimates do not indicate whether businesses are becoming more or less vulnerable to climate change over time.

Only very partial figures are available that show the impacts of extreme weather on UK businesses, and no indicators are available that show whether vulnerability and exposure is increasing or decreasing.

Figure 5.1 shows that the 2015/16 winter flood is estimated to have had an economic impact of £1.6 billion. Around a quarter of this impact was on business, higher than the impact on households or infrastructure.

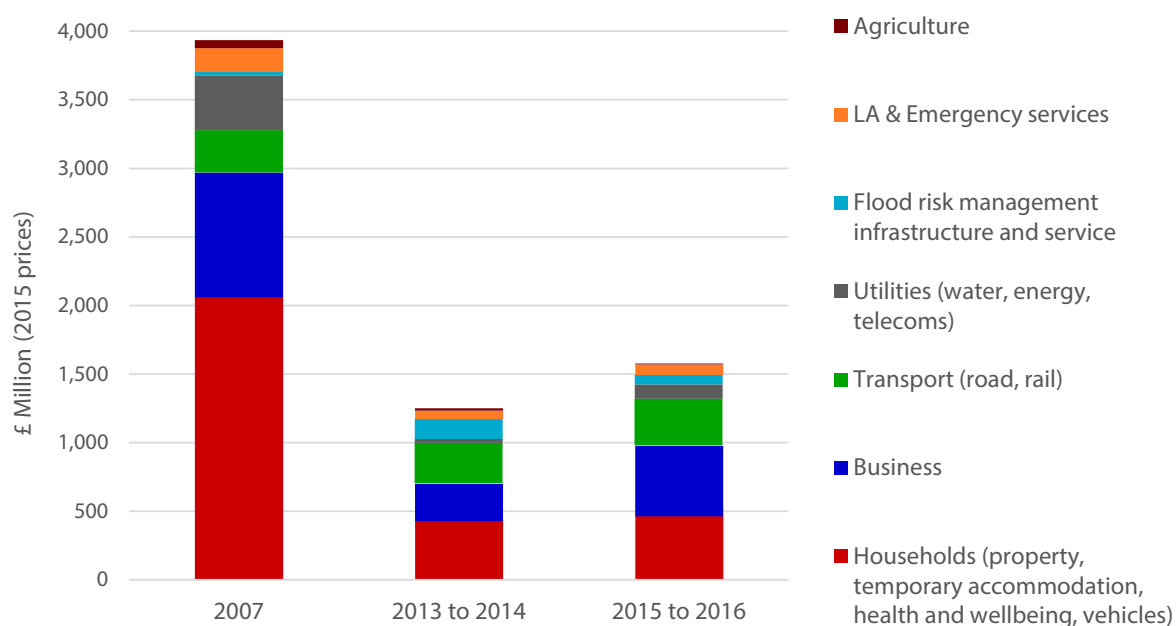
The economic impact and how it is divided between different sectors varies for different flooding events. There is the potential for even larger impacts on business, for example, the impact of the 2007 summer flood on business was double that for 2015/16, with the total impact on all sectors being around two and half times larger.

⁴⁰⁸ <https://www.spglobal.com/en/research-insights/articles/How-The-Recommendations-Of-The-Task-Force-On-Climate-Related-Financial-Disclosures-May-Figure-Into-Our-Ratings>

⁴⁰⁹ Bank of England (2018) *Transition in thinking: The impact of climate change on the UK banking sector*.

⁴¹⁰ Network for Greening the Financial System (2019) *A call for action: Climate change as a source of financial risk*.

Figure 5.1. Estimates of the economic impact of major floods



Source: Environment Agency (2018) *Estimating the economic costs of the 2015 to 2016 winter floods*.

Conclusion

Complying with the requirements of the Task Force on Climate-related Financial Disclosures (TCFD) creates an incentive for businesses to plan for how they may be impacted by climate change, though this is less likely to influence SMEs, the majority of businesses in England. While many large businesses have expressed support for the TCFD, this has not yet led to better assessment and planning for climate change risks and the current guidance does not require the consideration of higher climate change scenarios. Many businesses still do not have basic continuity plans for extreme weather, and there are no indicators available that help to show whether vulnerability and exposure is increasing or decreasing.

5.3 Supply chain interruptions

What is the risk?

CCRA2 found that business supply chains and distribution networks are disrupted significantly by adverse weather now. Such disruptions may become more frequent due to changes in exposure through economic growth and increased migration to coastal and urban areas, and changes in weather and climate hazards in the UK and overseas.

For the businesses concerned, this is likely to result in unfulfilled orders, breach of delivery contracts, loss of revenue and reputational damage. There may be areas where there are only a few companies providing key services (for example ICT and haulage), the resilience of which many other businesses depend on.

Case studies⁴¹¹ demonstrate that the international elements of UK businesses' distribution and supply chains are already impacted by weather-related disruptions. Supply chains that involve countries deemed highly vulnerable to climate change, such as in south and south-east Asia and in sub-Saharan Africa, will face higher risk in the future.⁴¹² Businesses' use of overseas markets as part of their supply chain or for distribution of goods and services can make them more resilient to domestic (and international) risks by creating alternative sources of supply in the case of disruption. However, this also creates exposure to climate change impacts abroad. The manufacture and supply of food, clothes and electronic equipment are understood to be particularly exposed to international climate change impacts.⁴¹³

CCC progress score	Reason for progress score
2	Plan score - low: There are no stated goals or specific planning for adapting supply chains, and the UK Industrial Strategy does not make any references to helping supply chains become more resilient to the impacts of climate change. NAP2 does not address the risks that the UK faces from the international impacts of climate change. Risk score - medium: The limited survey evidence available suggests some businesses are taking action but also suggests some do not engage with their suppliers on climate change.

Is there a good quality plan?

Are plans covered in NAP2?

The plans for supply chains in NAP2 focus on food security. Other sectors' supply chains will also be affected by the risks from climate change. NAP2 does not address the risks that the UK faces from the international impacts of climate change.

⁴¹¹ Surminski, S. et al. (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 6, Business and Industry*.

⁴¹² CCC (2014) *Managing climate risks to well-being and the economy*.

⁴¹³ CCC (2014) *Managing climate risks to well-being and the economy*.

Defra stated in NAP2 that climate change will be considered and highlighted both as a risk and an opportunity throughout its review of the Food Security Assessment, expected to be published by the end of 2019.

NAP2 does not set out any other plans for adapting supply chains to current or longer-term climate change, including consideration of different future climate scenarios. It states that actions under the health theme will help ensure adaptation has a higher profile in health and care organisations and that it is considered as an impact on supply chains, but NAP2 does not explain why this is the case. It also indicates that the Government will seek advice from the 25-year Plan's Council for Sustainable Business to develop and articulate the 'business case' for companies to assess, address and report on natural capital risks and opportunities in their operations and supply chains.

As highlighted in Chapter 1, the formal NAP2 actions do not cover any of the seven international risks from CCRA2.⁴¹⁴ CCRA2 highlighted the current and future importance of the international elements of UK businesses' distribution and supply chains. By neglecting these elements, current plans fail to address the risks in CCRA2 (see Chapter 1).

Are there other plans not mentioned in NAP2?

There are no stated goals for adapting supply chains to climate change or specific planning for 2°C and 4°C scenarios. A key plan, the UK Industrial Strategy, does not make any references to helping supply chains become more resilient to the impacts of climate change.

The UK Industrial Strategy aims to help UK businesses participate more in global supply chains and to consider how investments in infrastructure can best support supply chains and the export of goods and services. However, the strategy does not make reference to helping UK supply chains become resilient to the impacts of climate change now and in the future, despite the risks posed both domestically and internationally. One of the grand challenges of the strategy is around clean growth (i.e. low-carbon growth), but this is focussed only on the use of low-carbon technologies, not on sustainable growth, which would require consideration of adaptation.⁴¹⁵

The Government has announced a consultation to improve the way in which it takes account of social value in awarding contracts to suppliers, including adapting to climate change.

The Government spends £49 billion every year with external organisations.⁴¹⁶ In line with a recommendation from our 2017 report, earlier this year it announced a consultation on the way that Central Government takes account of social value in the award of its contracts.⁴¹⁷ Contracting authorities are already allowed to incorporate social and environmental aspects, including combating climate change, into specifications, award criteria and contract conditions through the 2015 Public Contracts Regulations. A new evaluation model proposes ways in which Departments can evaluate supplier responses and metrics to measure the delivery of key policy outcomes.

⁴¹⁴ Food supply is implicitly addressed as a Critical National Infrastructure sector and within the associated annual Sector Resilience plan. Other international risks are mentioned in the NAP text but were assigned no actions.

⁴¹⁵ BEIS (2018) *The Grand Challenges – Policy paper*.

⁴¹⁶ <https://www.gov.uk/government/news/businesses-urged-to-do-more-to-help-improve-society>

⁴¹⁷ Cabinet Office and DCMS (2019) *Social Value in Government Procurement – Open Consultation*.

To achieve the policy outcome of reducing environmental impacts, Departments should look for evidence that key suppliers would minimise or mitigate any negative environmental impacts and contribute to appropriate targets in the 25-year Plan, including mitigating and adapting to climate change, and reducing the risks of harm from environmental hazards. Suggested metrics include the number and type of initiatives to reduce environmental impacts and the annual percentage by which environmental impacts will be reduced, for example, water consumption. Such efforts could form the basis of a plan for adapting Government procurement processes.

Do the plans address the risks in CCRA2?

CCRA2 concluded that it was important to continue increasing understanding of risks to supply chains and distribution networks and enabling businesses with guidance and tools which are proven to be effective. While there are some plans for food supply chains and potentially for Government procurement, other sectors and international dimensions are not covered by any current or proposed plans. Overall, plans do not set out how understanding of the current and long-term risks across sectors will be increased or effective guidance and tools will be identified.

Is progress being made in managing risk?

Are relevant actions taking place?

Aside from publishing a plan for food security, the only other NAP2 action relevant for supply chains is for Government to continue delivering the Greening Government Commitments.

Discussed under 'Is there a good quality plan?' above, the only action in NAP2 under supply chains is:

- Review and publication of the updated UK Food Security Assessment (2018-2019).

Under 'Access to capital and risks and opportunities associated with changing demand for goods and services', one of the actions is relevant to procurement and supply chains:

- Government will continue delivering the ambitious Greening Government Commitments.

Greening Government Commitments (GGCs) set a range of environmental targets, including on water consumption, for Government Departments and their Arm's Length Bodies and ask them to report publicly on their actions on sustainable procurement and climate change adaptation. For example, the Ministry of Defence highlighted the work of a climate resilience working group for their Submarine Enterprise (see Box 5.2.). While the most recent GGC annual report notes slight improvement,⁴¹⁸ the previous year's report noted that in many any cases, the information on departments' actions under the transparency commitment areas, which includes climate change adaptation, is scant.⁴¹⁹ All reporting departments have a sustainable procurement policy in place but it is not clear to what extent, if any, resilience to current and future extreme weather is taken into account. The EAC is currently conducting a review of the GGCs which will include the Government's performance against them and how well they are aligned with other Government commitments.⁴²⁰

⁴¹⁸ Defra (2019) *Greening Government Commitments Annual Report April 2017 to March 2018*.

⁴¹⁹ Defra (2018) *Greening Government Commitments Annual Report - April 2016 to March 2017*.

⁴²⁰ <https://www.parliament.uk/business/committees/committees-a-z/commons-select/environmental-audit-committee/news-parliament-2017/greening-government-commitments-inquiry-launched-17-19/>

Box 5.2. Case Study – Ministry of Defence Submarine Enterprise Climate Resilience Working Group

The Submarine Enterprise Climate Resilience Working Group explores what risks a changing climate might pose to the Submarine Enterprise – for instance, understanding the impact of extreme weather on critical infrastructure and business processes; and what action might be required to manage such risks. Specific examples include building future climate-tolerant infrastructure, or de-risking key areas such as utilities or the supply chain. Topics such as high winds, heat waves, flooding, business continuity, and Ministry of Defence (MOD) climate policy and support networks have been covered. The group works in the spirit of collaboration, so technical sessions are led by those with information to share or experience/ lessons learnt to disseminate.

The working group is led by the MOD's Facilities Group (Submarine Delivery Agency) for the Submarine Enterprise Infrastructure Forum, and has representatives from the MOD and industrial partners. Representatives have a range of experience and responsibilities, with complementing operational and strategy skills. The group focuses on ensuring that the infrastructure and assets of today can still perform robustly when faced with the differing climate challenges of the future. Benefits to the Submarine Enterprise include:

- Raised awareness of climate change and environmental issues;
- Improved asset and infrastructure sustainability;
- Coherent approach to improve planning and communication;
- Better sharing of information and benchmarking;
- Better decision making through improved knowledge and analysis capability;
- Reduction in risk exposure;
- Improved business resilience; and
- Improved value from assets.

Source: Defra (2019) *Greening Government Commitments Annual Report April 2017 to March 2018*.

Businesses can access tools and guidance to improve the resilience of their supply chains to climate change.

Businesses are able to access tools and guidance through sources such as the TCFD Knowledge Hub. People and organisations can submit resources to be uploaded, which are then moderated to ensure they are relevant and accurate for publication.⁴²¹ To date, 479 articles have been uploaded, 29 of which specifically relate to supply chains and climate change. In particular, Acclimatise and PROADAPT created a Supply Chain Climate Risk Assessment tool.⁴²² The tool highlights both risks and opportunities to supply chains and suggests how businesses compare adaptation options.

Is there evidence that risk is being managed?

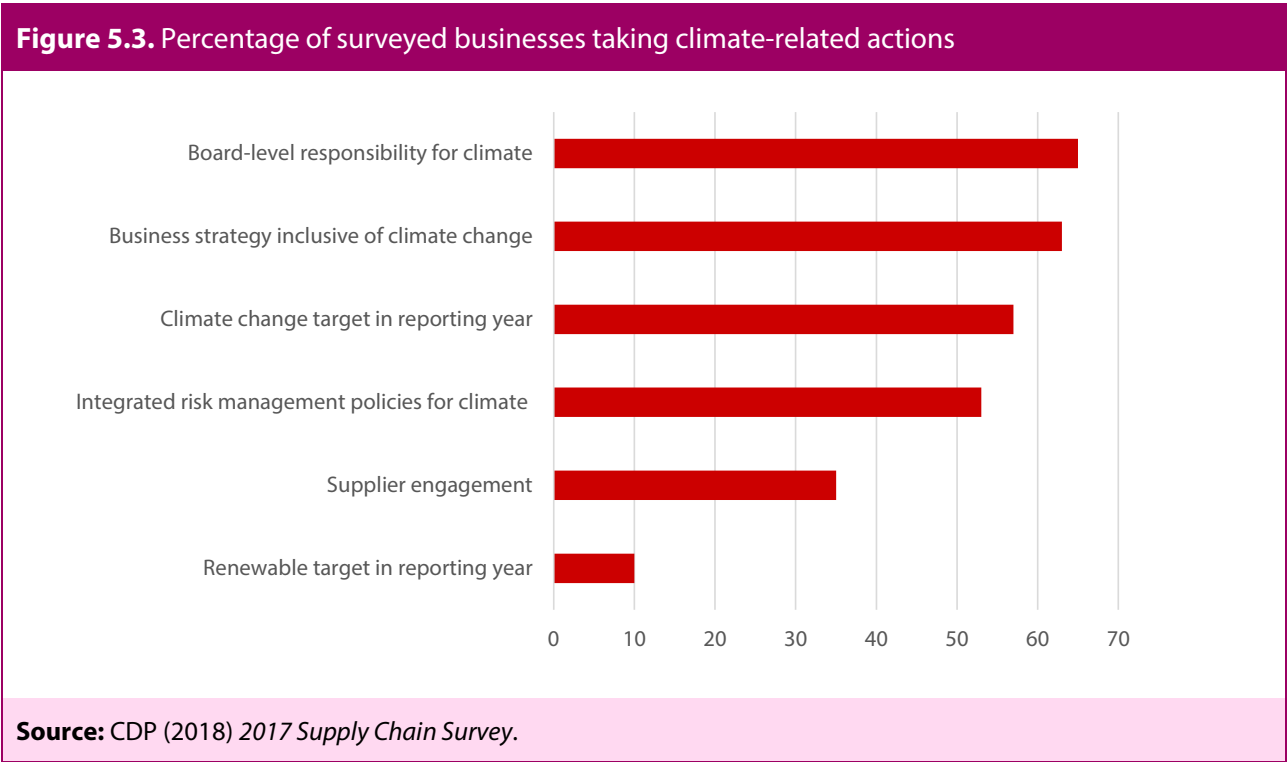
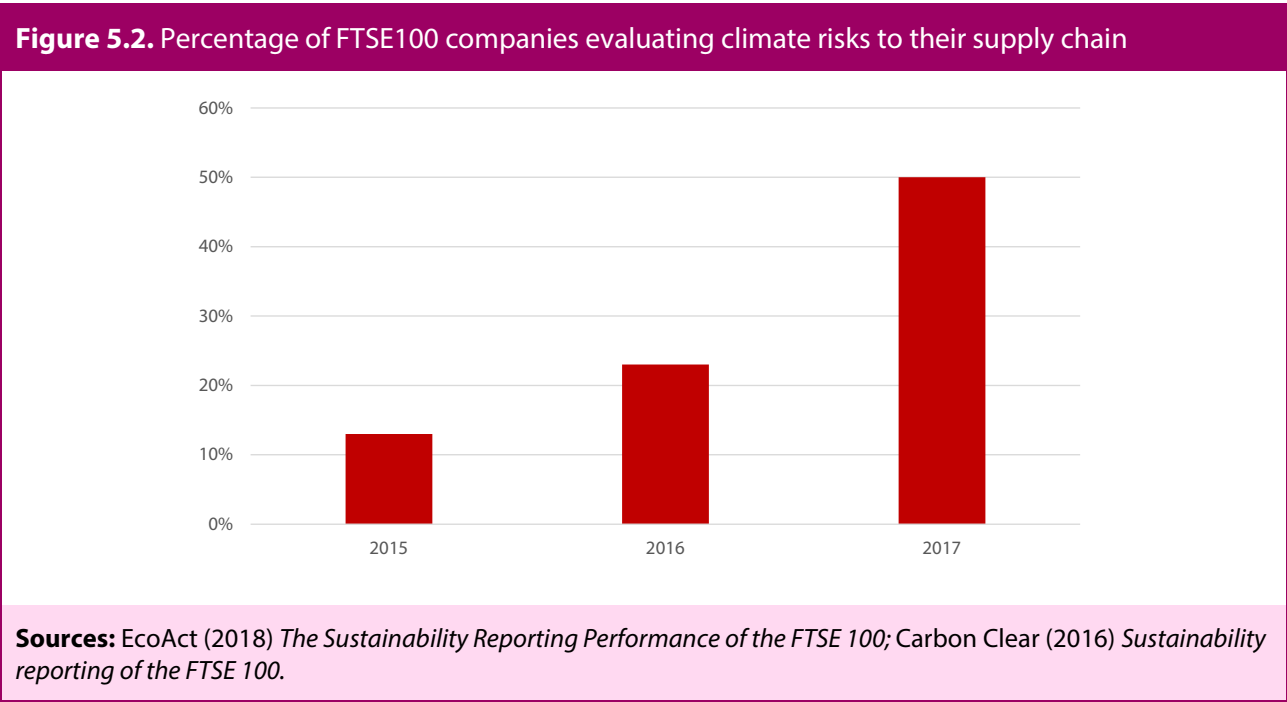
Surveys provide some insight into the other actions taken by businesses, but there are no data available to test the NAP2 vision of businesses being resilient to extreme weather and prepared for future risks and opportunities from climate change.

Various surveys ask businesses about the risks of extreme weather and climate change to their supply chains. These surveys give different indications as to whether UK business supply chains are becoming more resilient to climate change over time. For example, EcoAct assessed which FTSE100 companies are evaluating and reporting on climate risks to their supply chain.

⁴²¹ <https://www.tcfdhub.org/home/about/>

⁴²² Acclimatise for PROADAPT (2017) *Supply Chain Climate Risk Assessment Tool*.

Figure 5.2 shows their most recent results, which suggest that an increasing proportion of FTSE100 companies are doing this, with the proportion roughly doubling between 2016 and 2017. However, the responses to a different survey from CDP, shown in Figure 5.3, suggest that supplier engagement is less common than other business practices in response to climate change. In 2017, only 35% of UK respondents indicated that supplier engagement formed part of their climate change practices.



Conclusion

There are no stated goals or specific planning for adapting supply chains and the UK Industrial Strategy does not make any references to helping supply chains become more resilient to the impacts of climate change. The limited survey evidence suggests some businesses are taking action but also suggests some do not engage with their suppliers on climate change.

5.4 Water demand by industry

Water is discussed in several chapters of this report:

- Water in the natural environment is discussed in Chapter 2: Natural environment.
- Use of water by households is discussed in Chapter 3: People and the built environment.
- Supply-side measures and structural improvements to water company networks to reduce leakage, and be more resilient to severe weather, are discussed in Chapter 4: Infrastructure.

This section discusses progress made in reducing water use by businesses and industry.

What is the risk?

CCRA2 found that there are some catchments in England where abstraction demand is already in excess of the available resource in average low flow conditions.^{423,424}

Water scarcity may increase considerably in future depending on the level of climate change and population growth. In England, demand of more than 150% of the available resource is projected for catchments in the east and south in the 2050s under a high population and medium climate change scenario (between a 2.6 - 4.2°C global temperature rise by 2100 depending on the probability level used). In several catchments in the west of England it is projected that at times of low flows, there would be no water available for human use assuming that ecological flow requirements as currently set out would be met. CCRA2 found that a package of adaptation measures, including reducing abstraction by businesses by approximately 20% relative to the present-day baseline by 2050, could reduce significantly the number of catchments where demand exceeded the available water resource under a medium climate change scenario.

Typically, household consumption dominates the demand for water.⁴²⁵ However, some water resource zones have very high non-household public water supply demand reflecting the nature and intensity of local industry and businesses. Water-intense manufacturing sub-sectors such as chemicals and chemical products, basic metals, paper and paper products, beverages and food products are more vulnerable to water scarcity.⁴²⁶

⁴²³ The average of Q95 and Q70 is referred to as 'average low flows' in HR Wallingford et al. (2015).

Q95 is the river flow that is equalled or exceeded for 95% of the time. Q95 is a common low flow reference (and conversely, Q10 is a high flow reference). In HR Wallingford et al. (2015), Q95 refers to the 30-year annual average Q95 unless specified otherwise.

⁴²⁴ HR Wallingford et al. for the CCC (2015) *CCRA2: Updated Projections for Water Availability for the UK: Final Report for the Adaptation Sub-Committee*.

⁴²⁵ HR Wallingford et al. for the CCC (2015) *CCRA2: Updated Projections for Water Availability for the UK: Final Report for the Adaptation Sub-Committee*.

⁴²⁶ CCC (2014) *Managing climate risks to well-being and the economy*.

CCRA2 concluded that sustained action is required to create more flexible water abstraction systems and promote water efficiency among businesses.

CCC progress score	Reason for progress score
5	Plan score - medium: There are some plans in place to reduce water use by businesses through abstraction reform, the water retail market and company initiatives and targets. However, there is no overarching plan or target. The retail market could help to create incentives for businesses to become more water efficient but has so far only had a limited impact. Risk score - medium: While direct abstraction from freshwater sources has fallen, consumption from the public water supply is the same as in 2012. It is not possible to say whether businesses as a whole are improving their water efficiency, or if these changes are driven by economic or other trends, without additional data on production levels. There is good evidence that some businesses are reducing water use, for example reporting members of the Food and Drink Federation.

Is there a good quality plan?

Are plans covered in NAP2?

There is no specific target or plan mentioned in NAP2 to reduce water demand by industry. Businesses need to lower their water use to contribute to national efforts to address the risk of future water scarcity.

Businesses consume water from the public water supply and abstract water from the environment. While plans exist for demand management for the water sector as a whole (See Section 3.2.4), there is no specific target or plan to reduce the overall amount of water used by businesses in England. In NAP2, abstraction reform is the only plan which aims to address water demand by business.

Defra, Ofwat and the Environment Agency are working to achieve lower levels of non-household water use and reduce pressure on the environment through the operation of a non-household retail market for water and reform of the abstraction licensing system.

Defra laid a report before Parliament in May 2019 on the progress made in reforming the arrangements for managing water abstraction in England, meeting a requirement of the Water Act 2014.

Defra's report to Parliament set out key milestones in abstraction reform up until December 2027, when the Environment Agency will have updated all abstraction licensing strategies. See Section 2.6 for further discussion of abstraction reform.

Are there other plans not mentioned in NAP2?

The opening of the retail market for water offers multiple benefits for businesses but the potential effect on water efficiency is uncertain.

The water retail market for businesses in England opened in April 2017. Since then 1.2 million businesses, charities and public sector organisations have been able to choose who will supply them from among eligible retail suppliers. Among the benefits to businesses of choosing among retailers, Ofwat lists both advice on saving water and lower prices.⁴²⁷ The potential effect of the retail market on water efficiency is uncertain. If suppliers compete with one another by offering water at a lower price, businesses could afford to consume more. Alternatively, suppliers can compete with one another or differentiate by offering better water efficiency services to attract customers, leading to businesses using less water than before.

Do the plans address the risks in CCRA2?

Abstraction reform and the opening of the retail market could lead to more efficient use of water by businesses. However, without a specific target or plan to reduce water demand by industry that considers the size of the long-term risks from climate change, there is no assurance that the sustained action that CCRA2 identified as being required to address the risk will be achieved.

Is progress being made in managing risk?

Are relevant actions taking place?

Aside from actions on abstraction reform (see Section 2.6), NAP2 contains no specific actions to achieve lower water use by businesses.

Reviews suggest that the retail market is not yet reaching its potential, particularly in terms of helping businesses to become more water efficient.

An inquiry into the regulation of the water industry by the Environment, Food and Rural Affairs (EFRA) Committee, found that while the opening of the retail market has been generally considered to be a good thing, the first year delivered unimpressive results for water efficiency.⁴²⁸ Research by Waterwise found that less than half of retailers were offering key services such as leak detection and some wholesalers reported that non-household water use had actually increased since the market opened.⁴²⁹

Ofwat's review of the first year of retail competition also concluded that there was considerable potential for retailers to offer, and customers to take up, further water efficiency services.⁴³⁰ Customers who switched or renegotiated saved around £8 million in total and at least 270 to 540 million litres of water due to efficiency measures. However, take up of these services in the first year was very low, with just 0.2% of switchers reporting water efficiency and leak reduction services as a benefit of switching. 80% of customers active in the market said water efficiency, leakage control and enhanced metering services were very or fairly important, suggesting there is appetite for such services.

There is scope for regulators and water companies to do more to create incentives for businesses to reduce their water use.

⁴²⁷ <https://www.ofwat.gov.uk/nonhouseholds/choosing-your-supplier/>

⁴²⁸ Environment Food and Rural Affairs Committee (2018) *Regulation of the water industry*.

⁴²⁹ Waterwise (2018) *Assessing water efficiency services offered by water retailers*.

⁴³⁰ Ofwat (2018) *Open for business: Reviewing the first year of the business retail water market*.

In addition to the retail market and abstraction reform, there may be other ways in which the Environment Agency, Ofwat and water companies can create incentives to reduce water demand from industry. A recent example is a pilot scheme by Thames Water.⁴³¹ It is offering a one-off payment of 5p per litre per day of water saved for each of a retailer's non-household customers, with the initiative set to run to March 2020. Retailers will have to demonstrate water savings through comparing three months of meter data before and after any water efficiency interventions are made.

There are examples of companies setting targets and initiatives to reduce consumption of water but not all of these demonstrate improvements in water efficiency.

Water use metrics and targets are among the more common metrics and targets reported by companies with regard to their resilience to climate change.⁴³² In their 2018 European Report, CDP stated that 92% of businesses reporting on water had some sort of target or goals in place within their operations, up from 61% the year before.⁴³³ In many cases these targets are based on absolute reductions by a certain year. In these cases changes in performance may be linked to changes in production rather than genuine improvements in water efficiency.

Members of the Food and Drink Federation (FDF) have committed to contribute to an industry-wide target: to reduce water use outside of that embedded in products by 20% by 2020 relative to a 2007 baseline.⁴³⁴ Reporting members of the FDF had reduced their water use by 39% in 2017 relative to the 2007 baseline. Data suggest that this was due to improvements in efficiency as water intensity had decreased from 2.5m³ per tonne of product in 2007 to 1.5m³ in 2017.

CDP carried out a global assessment, including the UK, of companies' exposure to water stress across their value chain and evaluated their water management processes and targets.⁴³⁵ The assessment found that despite almost a doubling of the number of companies setting targets to reduce water withdrawals over four years, there was an almost 50% rise in the number reporting higher water withdrawals. This trend was for both company-wide withdrawals but also for those at sites facing substantial risks. Some organisations, such as Diageo and L'Oreal, did perform highly in the assessment by having practices such as reviewing water use across their supply chain.

Is there evidence that risk is being managed?

Direct abstraction of water by businesses has fallen in recent years, but progress in reducing consumption of the public water supply has stalled. It is not possible to tell whether businesses are becoming more water efficient without additional data on production trends.

Businesses are responsible for around 9% of abstractions from freshwater sources, a relatively small proportion compared to abstractions by the public water supply and by the electricity supply industry.

⁴³¹ <https://corporate.thameswater.co.uk/Media/News-releases/Thames-Water-launches-industry-first-water-efficiency-cash-scheme-for-retailers>

⁴³² Task Force on Climate-related Financial Disclosures (2018) *2018 Status Report*.

⁴³³ CDP (2018) *Higher Ambitions, Higher Expectations – CDP Europe Report 2018*.

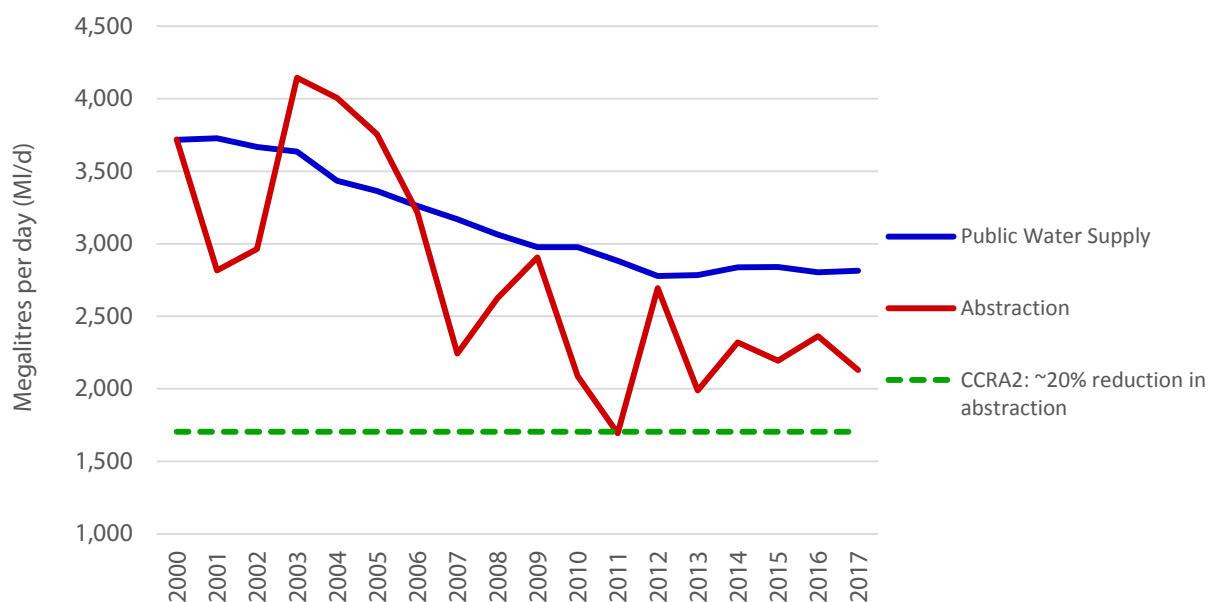
⁴³⁴ <https://www.fdf.org.uk/water-progress.aspx>

⁴³⁵ CDP (2019) *Global Water Report*.

Abstraction by businesses⁴³⁶ fell by around 8% from 2014 to 2017 but remains higher than in 2013 (Figure 5.4). These changes could be the result of changes in production levels or other trends rather than improvements in water efficiency. It is not known how many abstraction licences held by businesses have been adjusted as part of abstraction reform to date.

Non-household consumption of the public water supply fell by about 25% between 1999 and 2012 (Figure 5.4). It is not known if this is due to improvements in efficiency, changes in production levels or how these could differ among sectors. Since 2012, non-household consumption of the public water supply has remained at roughly the same level. CCRA2 found that a package of adaptation measures, including reducing abstraction by business by approximately 20% relative to the present-day baseline by 2050 (shown in Figure 5.4), could significantly reduce the number of catchments in the 2050s and 2080s where demand exceeded the available water resource under a high population and medium climate change scenario (between a 2.6 - 4.2°C global temperature rise by 2100 depending on the probability level used).

Figure 5.4. Abstraction from freshwater sources and non-household consumption of the public water supply, 2000 to 2017



Source: CCC analysis; Environment Agency (2019) *Estimated abstractions from all sources except tidal by purpose and EA regional charge area: 2000 to 2017*; Environment Agency (unpublished); HR Wallingford et al. for the CCC (2015) *CCRA2: Updated Projections for Water Availability for the UK: Final Report for the Adaptation Sub-Committee*.

Notes: Data for abstraction are split into the following categories: Public water supply, Spray irrigation, Agriculture (excl. spray irrigation), Electricity supply industry, Other industry, Fish farming and cress growing and amenity ponds, and Private water supply. 'Other industry' is referred to as abstraction by businesses in this chapter. CCRA2 found that a package of adaptation measures, including reducing abstraction by business by approximately 20% relative to the present-day baseline by 2050, could reduce significantly the number of catchments where demand exceeded the available water resource under a medium climate change scenario (between a 2.6 - 4.2°C global temperature rise by 2100 depending on the probability level used).

⁴³⁶ Data for abstraction are split into the following categories: Public water supply, Spray irrigation, Agriculture (excl. spray irrigation), Electricity supply industry, Other industry, Fish farming and cress growing and amenity ponds and Private water supply. 'Other industry' is referred to as abstraction by businesses in this chapter.

Conclusion

There are some plans in place to reduce water use by businesses through abstraction reform, the water retail market and company initiatives and targets. However, there is no overarching plan or target. The retail market could help to create incentives for businesses to become more water efficient but has so far only had a limited impact. While abstraction has fallen, consumption of the public water supply is the same as in 2012. It is not possible to say whether businesses across the board are improving their water efficiency without additional data on production levels, though there is clear evidence that some businesses are doing well in this area.

5.5 Business opportunities from climate change

Business opportunities from climate change mitigation (low-carbon) activities are not considered in this section, which focuses on how climate change globally could increase the demand for certain adaptation-related goods and services, and as a result create new market and export opportunities for UK businesses. In addition, climate change in the UK may have some beneficial effects for certain businesses and industries.

What is the opportunity?

Climate change will affect the production costs and demand for certain goods and services, increasing the profitability of some and decreasing that of others. Businesses that anticipate changing markets may be able to gain an advantage, as well as profit from specific adaptation-related goods and services such as water engineering, climate risk insurance, adaptation finance, and precision farming technologies. With sufficient information and climate change expertise, businesses can be expected to respond to market signals and exploit these opportunities as they arise. Smaller businesses may be unable to overcome adaptive capacity constraints and therefore are less likely to realise the opportunities from climate change.

CCC progress score	Reason for progress score
2	Plan score - low: There is no overarching plan and the Industrial Strategy does not mention climate change as a potential driver of business growth or city regeneration through adaptation-related technologies. There are no specific schemes from Innovate UK or use of the Industrial Strategy Challenge Fund to encourage climate-related adaptation opportunities. Risk score - medium: Opportunities have been identified for banking and green finance which have the potential to direct more finance towards adaptation and develop new adaptation products and services. The available data do not demonstrate the extent to which businesses are realising the opportunities from climate change.

Is there a good quality plan?

Are plans covered in NAP2?

There is no overarching plan in NAP2 for supporting UK businesses to realise the opportunities from climate change.

The NAP2 section on access to capital and opportunities associated with changing demand for goods and services has four sub-sections:

- Non-financial reporting.
- Green finance.
- Greening government commitments.
- Climate adaptation standards.

Beyond highlighting the potential for each of these to lead to greater consideration of opportunities, there is almost no consideration of specific sectors or a plan to develop a greater understanding of the size of the opportunities in question, including differentiating between 2°C and 4°C global temperature scenarios. There is more focus on green finance products and services and how the UK's strength in this area could enable growth in other sectors.

The Government's forthcoming Green Finance Strategy provides an opportunity to direct more finance towards adaptation and develop new adaptation products and services.

Green finance is a growing area, with issuance of green bonds and efforts to incorporate environmental issues into conventional finance increasing, and initiatives like the TCFD gaining support from large corporates. In order to keep the UK competitive and finance its Clean Growth Strategy, the Government convened a Green Finance Taskforce (GFT) to advise on how to accelerate the growth of green finance.⁴³⁷ Since the GFT reported, the Government and City of London have agreed to co-fund a Green Finance Institute which will act as a centre for future UK green finance activity. As stated in NAP2 the Government will respond and build on the work of the GFT through a Green Finance Strategy, expected to be published in summer 2019.

Most established green finance products relevant for climate change are focussed on mitigation rather than adaptation. The CCC's report on housing recommended that the Government should widen the scope of Green Finance measures, for example including water efficiency, flood and heat resilience and introducing resilience surveys. It also recommended that Government should work with the National Infrastructure Commission and others to promote research and development, and develop standards for new homes.⁴³⁸

Are there other plans not mentioned in NAP2?

The Industrial Strategy does not reference climate change adaptation and it is left up to the industries who could benefit from climate change to consider the opportunities.

The Industrial Strategy does not reference climate change adaptation or highlight those sectors that may benefit from the changing climate. There are no specific schemes from Innovate UK or use of the Industrial Strategy Challenge Fund to encourage climate-related opportunities. Data are not collected on the sales of adaptation goods and services and there are no plans for research to further explore potential opportunities.

⁴³⁷ Green Finance Taskforce (2018) *Accelerating Green Finance*

⁴³⁸ CCC (2019) *UK Housing: Fit for the Future?*

Certain industries in the UK such as agriculture, horticulture, forestry and tourism, may benefit from climate change in the UK due to more favourable climatic conditions emerging relative to other parts of the world. The UK has considerable expertise in areas such as science, engineering, insurance, and finance. There could be justification for focussing more on adaptation goods and services from these sectors.

Some industries who may benefit in part from the changing climate have made plans to expand their production. For example, the English Wine Round Table with the Wine and Spirit Trade Association and Defra made pledges to increase wine production to reach 10 million bottles, with the ambition that 25% of this would be exported.⁴³⁹ This would be a tenfold increase in exports, resulting in over £30 million in revenues by 2020. Looking further ahead, Wines of Great Britain has estimated that in 2040 annual production could reach 40 million bottles (see Section 2.6).

The Industrial Strategy sets an expectation that research laboratories in receipt of significant public funding should support local economic growth.

Following a review by Professor Dame Julia Goodfellow, the Industrial Strategy set an expectation that research laboratories receiving significant public funding should build sustained partnerships with local businesses.⁴⁴⁰ The Industrial Strategy highlights the climate and weather modelling capabilities of the Met Office in particular, and the use of these capabilities to examine climate change and the UK's resilience to extreme weather events. BEIS is undertaking further work to understand the barriers to partnerships between research laboratories and local businesses and how to overcome these.

Do the plans address the opportunities in CCRA2?

CCRA2 found that with sufficient information and climate change expertise, businesses can be expected to respond to market signals and exploit opportunities as they arise.

The plans that are supposed to consider the opportunities from climate change at a national level do not demonstrate a systemic consideration of the sectors that could benefit or an understanding of the size of the opportunities in question. Therefore there is little assurance that the English businesses who stand to benefit will realise the opportunities from climate change, particularly smaller ones, and that the case for providing further information or support has been considered. Government-funded adaptation support services have ceased in the last two years (see Chapter 1).

Is progress being made in managing opportunity?

Are relevant actions taking place?

NAP2 actions to realise opportunities are very general with only green finance receiving specific consideration.

NAP2 actions for access to capital and risks and opportunities associated with changing demand for goods and services include:

- Government will consider the recommendations of the Green Finance Taskforce and respond in due course.

⁴³⁹ Watkiss, P., Cimato, F., Hunt, A. and Moxey, A. for the CCC (2019). *The Impacts of Climate Change on Meeting Government Outcomes in England*.

⁴⁴⁰ HM Government (2017) *Industrial Strategy*.

- Government will continue delivering the ambitious Greening Government Commitments.
- Government will continue engaging with BSI on the consideration of a need of a potential new standard on adaptation for businesses.

In this section, NAP2 states that an area the 25-year Plan's Council for Sustainable Business could act and provide advice on is developing and articulating the business case for natural capital reporting and addressing risks and opportunities in operations and supply chains.

There is some evidence that large businesses are considering the opportunities from climate change and exploring new ways of financing adaptation.

Several surveys suggest that large businesses are increasingly considering the opportunities from climate change. In 2018, 64% of the FTSE100 considered climate change a business opportunity, up from 25% in 2012.⁴⁴¹ Previous research for the CCC estimated that the sectors responsible for generating the most revenue from adaptation-related goods and services were construction and retrofit and transport infrastructure.⁴⁴² Evidence from the CCC's 2019 report on housing as well as the implications from the Grenfell inquiry suggests that there is scope for these sectors to greatly increase their output of goods, services and skills for more resilient buildings and infrastructure.

In 2017 Anglian Water became the first European utility company to issue a sterling green bond.⁴⁴³ The bond of £250 million will mature in August 2025 and offers a return to investors of 1.625%. The money raised is intended to finance a range of activities, including water abstraction projects, drought and flood resilience schemes, and water recycling projects. So far, Anglian Water has spent £276 million on schemes funded by the green bond, including a wetland restoration project in Norfolk.⁴⁴⁴

The Bank of England has identified a number of opportunities for banks from climate change and the issuance of green bonds has increased over recent years.

To inform the Bank of England's 2018 report on climate change, the Prudential Regulation Authority carried out a survey of 90% of the UK banking sector representing over £11 trillion in assets.⁴⁴⁵ The results of this survey and of bilateral meetings with firms and stakeholders highlighted that climate change will provide opportunities as well as risks to banks. Commercial lending and advisory services to meet the needs of new and emerging sectors was identified as an opportunity, although mostly in the context of renewable energy and decarbonising the economy. Other opportunities included green 'securitisation',⁴⁴⁶ which will help provide finance from institutional investors, and opportunities for banks as underwriters or issuers of green bonds.

⁴⁴¹ EcoAct (2018) *The Sustainability Reporting Performance of the FTSE 100*; Carbon Clear (2016) *Sustainability reporting of the FTSE 100*.

⁴⁴² CCC (2014) *Managing climate risks to well-being and the economy*.

⁴⁴³ Green Bonds enable capital-raising and investment for new and existing projects with environmental benefits. International Capital Market Association (2018) *The Green Bond Principles*.

⁴⁴⁴ Anglian Water Services Limited (2018) *Annual Integrated Report 2018*.

⁴⁴⁵ Bank of England (2018) *Transition in thinking: The impact of climate change on the UK banking sector*.

⁴⁴⁶ Securitisation enables companies and lenders to sell financial instruments, such as bonds, backed by financial assets, such as mortgages. A securitisation can be defined as green when the underlying cash flows relate to assets with environmental benefits or where the proceeds from the deal are earmarked to invest in assets with environmental benefits. Climate Bonds Initiative (2018) *Green Securitisation Unlocking finance for small-scale low carbon projects*.

During 2017 there were 27 green bonds listed in London, raising \$10.9 billion compared to 14 green bonds in 2016 that raised \$5.65 billion. In November 2017 alone there were seven green bonds listed in London by Australian, Danish, Finnish, Indian, Japanese and UK institutions. However, there has been far less issuance of green bonds in the UK than France or Germany. Barclays became the first UK bank to offer a green bond on the London Stock Exchange, raising €500m.⁴⁴⁷ An inaugural Dutch Sovereign Green Bond was recently auctioned and the proceeds are being used to fund a number of projects including water infrastructure for flood defence and water distribution.⁴⁴⁸

To support the acceleration of green finance, new products and guidance are being created. For example the EU High-Level Expert Group on Sustainable Finance is creating a green taxonomy, and the BSI is carrying out work on new standards for green finance.

Is there evidence that risk is being managed?

From the available data it is not possible to tell the extent to which UK businesses are realising the opportunities from climate change.

Understanding the size of the adaptation market opportunity in the UK (and England) is challenging for several reasons. There are very few companies that focus solely on adaptation-related goods and services, with these normally part of a wider and more general offering. Attributing market and company level activity to climate change adaptation is therefore difficult.

It is possible to look at production or sales data for some products that will benefit from global climate change, impacts within the UK, or that are related to adaptation. For example, wine production, sales of permeable paving and the area of substrate sold for green roofs.⁴⁴⁹ However, without taking account of changes in overall economic activity, it is not possible to say if these changes are evidence of increased demand or of realising the opportunities from climate change.

Conclusion

There is no overarching plan and the available data do not demonstrate the extent to which businesses are realising the opportunities from climate change. Opportunities have been identified for banking and green finance which have the potential to direct more finance towards adaptation and develop new adaptation products and services.

⁴⁴⁷ EAC (2018) *Green finance: mobilising investment in clean energy and sustainable development*.

⁴⁴⁸ <https://www.climatebonds.net/2019/05/dutch-sovereign-gb-eur21bn-orders-35-times-oversubscribed-climate-bonds-certified-20-year>

⁴⁴⁹ ADAS for the CCC (2019) *Research to update the evidence base for indicators of climate-related risks and actions in England*.



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